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[SECOND SERIES.]

Art. I.—*Evidences of Glacial Action on the Green Mountain Summits;* by Edward Hungerford.

There are in Vermont five peaks belonging to the Green Mountain range, which rise to an elevation of more than four thousand feet. In the order of position, commencing on the north, we have first Jay Peak, 4018 feet; Mount Mansfield, 4430 feet; Camel's Hump, 4088 feet; Lincoln Mountain or Potatoe Hill, 4078 feet; and Killington Peak, 4221 feet above tide. The elevations are given on the authority of Prof. Guyot.

In my recent excursions to several of these summits, I have been able to study the evidences of glacial action at those elevations, and to accumulate a number of observations, beyond those which have been alluded to by others; so that we are now placed in a situation to review and sum up the principal facts, bearing upon the question of the height to which such action has extended in this state, and upon that of the probable thickness of the accumulation of ice and snow in the glacial epoch.

The attention of the earlier geologists of the State was prominently directed to the drift phenomena, and, in speaking of the elevation to which "drift furrows" extend, Prof. C. B. Adams remarks: "They exist abundantly on Jay Peak.... The furrows were found a few yards east of the highest westerly point, and six or eight feet below it, and were continued over the east part of the Peak with a direction from north 40°

west,* as nearly as could be determined over a talcose slate which abounded with crystals of magnetic ore."†

Mount Mansfield presents a long elevated ridge, which attains, in the Chin, its greatest elevation of 4430 feet, while the Nose, at the southern extremity of the ridge, rises to the height of 4094 ft. above the sea. The evidences of glacial action around the summits of this ridge are very decided. The grooves mentioned in the final report of our State Geologists, in close proximity to great transported blocks under the Chin, at an elevation of about 4080 feet, are well preserved, and I was able to obtain the following corrected readings of compass, indicating the direction of approach of the glacial mass, viz: N. 23° W., and N. 25° W., (two readings on the same line), also N. 28° W. on another furrow. One of the transported blocks, 25 feet long, 15 feet wide, and 11 feet high, was doubtless torn from another portion of the mountain, and its present position, as it lies perched upon and supported by another smaller boulder, indicates that it had been first lifted, and then had settled down into its resting place. The surface of the rock in situ, under the great boulder, is rounded, so as to denote an erosive action, previous to the deposition of the mass upon it. A fine stereoscopic view of this boulder, under the name of the "Drift Rock," is sold by A. F. Styles of Burlington. Very distinct groovings are also found on the eastern slope of the ridge, only about fifty or one hundred feet below the mountain house, directly in the bridle path that leads to Stowe. These furrows are estimated to be about 3800 feet above the sea, and correspond in their general direction with the furrows observed on the western face of the mountain near the boulders described above.

A very beautiful evidence of glacial action is furnished by the polished knobs of quartz, on the top of the Nose, at an elevation of 4094 feet. Numerous such quartz masses are found projecting from the matrix of the rock, and these are often very smoothly and handsomely polished. In a good light, fine striations are visible upon these knobs, as is shown in a small hand specimen brought by me from this locality.

On the summit of Camel's Hump, which rises 4088 feet above tide, the principal evidences of glacial action, consist in the polishing of the quartz knobs and the rounding of the sides of cliffs, the former being observable upon the summit itself, and the latter having been traced to within some fifty or one hundred feet at least of the highest point. No grooves or furrows, except the fine lines upon quartz, were found upon the summit, although extended search was made for them. The preservation of such furrows in the extremely friable rock must be rare, though they may yet be detected in the immediate vicinity of the summit on some freshly exposed surface. The rounding of the cliffs, upon the northern side of the final ascent, within the above named distance of the highest point, is so conspicuous as to at once attract attention. The highest level at which distinct grooves were observed is judged to be about 700 feet below the summit, or nearly 3400 feet above the sea. At this point, in the bridle path which descends the northern or northeastern face of the mountain toward Ridley's Station,* in the Wooski Valley, the bearing of the grooves was N. 20° W. and again N. 40° W., the latter being on a side of rock and deflected. The ledge at this point was handsomely polished. The course of the moving ice on this stossward flank of the mountain, was undoubtedly determined, in part, by the barrier which the mountain itself presented to its progress.

---

* True bearing. The readings of compass given in this article are all corrected readings, 10° western variation being allowed.

† Second Annual Report on the Geology of Vermont, by C. B. Adams.

The evidence of glacial motion afforded by the polished quartz knobs, both on Mount Mansfield and on Camel's Hump, is of such value as to require some special notice. These smoothed massses of quartz I have examined on both mountains, and from both localities I have brought away small specimens for closer inspection. That from the top of the Nose, on Mansfield Mountain, retains very distinctly the fine, sharply cut, glittering hair-lines, which were graven upon it by the fine grit of the glacier, or by points of hard mineral frozen into the moving mass.

The specimens from Camel's Hump were less distinctly striated, the lines not having been so sharply cut, or not so well preserved. But, in these also, the direction of the polishing motion is very readily detected from the general character given to the surface by the minute gravings. In order to test this point, and to correct any possible influence of habit, or of prejudice in myself, I invited my host of the Mountain House, who was unacquainted with such observations, to determine independently the direction of the polishing force. His determination coincided with my own. The directions as determined upon the mountain were marked upon the masses in pencil before breaking them off from the rock, and the observations confirmed by careful examinations at home. The lines are much more distinctly brought out by moistening the surface.

---

* The point on the Vermont Central R. R. from which the ascent is made.

In the absence of other indications of glacial action, s
masses are valuable for determining the former presence
such an agency, and the direction of the moving force.

The bearings taken upon the summit of Camel's Hump a
based upon these determinations on quartz knobs, differ ma
rially one from another. I obtained the following correc
readings at different points on the summit. In one insta
N. 10° E., in another N. 10° E. to North, and in a third
35° W. The two former bearings were taken at points
ward the northern side of the summit, the last at a poi
somewhat more sheltered from a force of northern orig
These variations in direction seem to me to indicate that t
glacial mass, as it enveloped this peak, flowing over and arou
it, had its partial motions entirely governed by the rocky o
struction, while the general current of the glacier maintain
its course. Must not the slow motions of such a glacier co
form in this respect, as well as in others, to the law governi
the flow of water; that, while the main current keeps i
course, the subordinate and local currents are directed alo
and around every considerable obstruction in the way of t
stream?

Killington Peak rises 4221 feet above tide. Its bare su
mit of gneiss, twelve miles back, or eastward from Rutlan
is easily reached, and well repays a visit. I observed no stri
tions upon this mountain; no quartz knobs projecting co
spicuously from the rocky matrix, and retaining distinct trac
of glacial motion. The sharp terminal peak is much torn
frost and lightning, so that one clambers to the top over
steep talus of fallen masses. There is, in the last twenty fe
of the elevation, a pretty well defined northern stoss side, an
over this part of the peak, the rounding off of the rock is su
ficiently well marked. The point of most interest, howeve
in connection with Killington Peak, is the occurrence of n
merous, small, well rounded boulders of foreign rock upon
offset within twenty feet of the highest point. The most co
spicuous of these, perhaps, are of quartz rock, varying in si
up to a foot or a foot and a half in diameter. They are we
rounded, and were traced all along the higher portion of t
mountain up to this point. The material of these boulde
or pebbles differs in its character, that of a true granul
quartzite, from the hyaline quartz contained in the gneiss
the summit. These are true transported pebbles, lifted to th
elevation from some lower point, probably from the quar
range to the northwest. With the quartzite pebbles are al
found pebbles of gneiss, with rounded edges, and of a ve

different character from the gneiss constituting the summit. The home of these gneiss pebbles is not known to me.

It will be seen from this survey of the elevated peaks of the Green Mountains, that they present in every instance, where an examination has been had, decisive marks of glacial action around their extreme summits. The conclusion follows that those summits have been enveloped by glacial ice, which must have been in each case either the beginning of a glacier descending from the summit, or else a part of an extended ice mass, moving over the entire surrounding country. Against the former supposition might be adduced the form of these mountains, which, in every instance except that of Mount Mansfield, is that of a single isolated peak on which no gathering places for large masses of snow offer themselves, as also the fact that their rounded slopes point uniformly in the case of those I have visited, Mansfield, Camel's Hump, and Killington, to the northward, while abrupt precipices face southward and eastward. Still more conclusive on this point is the presence of quartzite boulders on the summit of Killington Peak, which have had their origin in remote beds at a lower level.

Art. II.—*Notes on the Quicksilver Mine of Santa Barbara, in Peru.* Condensed from a MSS. Report made to the New Almaden Quicksilver Co., by C. E. Hawley, M. E.

This mine, which has been worked since 1570, is situated on a bold promontory or Farallon in the summit of the range about 1200 feet above and on the south side of the river Huancavelica. The strata containing the cinnabar rise almost vertically from the valley, being light-colored sandstone, with occasional layers of bluish-gray limestone. The metalliferous stratum spreads out in places to a width of forty or fifty yards, running N. and S., and dipping westerly. The mine, which is naturally a very safe one to work, has been so carelessly and ignorantly opened as to have led at various times to extensive ruins and great loss. The present condition of the mine is deplorable, owing principally to the reckless system of the last lessor, who robbed the mine of every pillar, and like his predecessor made no new works to open fresh bodies of ore. In St. Domingo de Cochapata, in the bottom of the mine, over one hundred Indians were buried at one time.

In 1681 the ore which fell in the "labores" of the San Jacinto, and was afterward extracted, produced four thousand flasks of quicksilver. The crush in 1786 from the falling in of

the upper "labores" of Santa Rita, left a yawning chasm 2
feet deep. The repairs of these damages during the worki
of the Santa Barbara mine have amounted probably to seve
millions of dollars. This has occurred in a mine safer a
easier to work by far than the New Almaden in Californ
Extravagant sums have been expended on the great tunnels
this mine; that of Belen cost the Spanish Government nea
a million and a quarter of dollars.

Since the Peruvian Independence, but little attention h
been bestowed on this mine, which, after 300 years, is now aba
doned to a few Indians who collect and reduce small quantit
of ore from the superficial works. Most of the great wor
are closed by caving, or by the accumulation of carbonic ac
gas. The grand tunnel is about 2000 feet long and from t
to twelve feet wide and high, connecting with an incline-tu
nel about five feet wide and high, running down at an an
of 15° to the ore. Omitting many details of the ancient wor
ings now for the most part clogged or irreparable, it appe
from the evidence of the explorations that the bodies of
have not occurred in regular vein-like or continuous mass
as at Almaden in Spain. The ore of the "labor" of San
Inez, fully twelve feet thick and extending probably 150 fe
to the "labor" of Santa Cataline, consists of a base of da
colored sandstone spotted in places with bright red particles
cinnabar and again containing cinnabar invisible to the nak
eye. Large quantities of sulphuret and sulphate of iron occ
in connection with the ore, which rarely contains so much
two and a half per cent of mercury. Large bodies of iron p
rites are said to have been left standing in the lowest depths
the mine, which, if worked, would probably yield more mercu
than the average ore of the mine. The lowest point the auth
was able to reach was evidently the beginning of the lar
bodies of ore of the mine.

Leaving the mine on the side of the grand tunnel he exa
ined the bold promontory of sandrock overlooking the city a
river of Huancavelica, and marking the extreme north end
the workings of Santa Barbara. This is an immense body
stratified rock of about fifty yards thickness running north a
south and standing nearly vertical. A portion of it, averagi
about one-third of the whole, is impregnated with cinnabar
very poor quality. About two hundred yards south of i
summit is the point called the Brocal, and to the south of t
Brocal, a short distance, the strata bury themselves below t
surface to re-appear again only at a distance of about fifte
hundred yards. The whole body of the mine at the Brocal
one vast ruin, and the percentage of the surface ore is too l

to make it valuable. A deep tunnel, commenced during the past century, and extended about 200 yards from the foot of the promontory, but still six hundred yards from the old workings of the Brocal, is the only mode of developing these beds in depth where tradition tells of rich and extensive bodies of ore. Extensive workings running to the westward are approached by the Puerto de Santo Domingo, standing midway between the promontory and the Brocal. Here are numerous large chambers rapidly going to ruin, excavated in a light-colored sandstone containing cinnabar in minute quantities, amounting to less than half of one per cent. In the same strata with the Santa Barbara, and in close proximity, are six or eight other mines belonging to private individuals, formerly productive but now abandoned.

In the vicinity of Huancavelica there are no less than forty-one well recognized ranges of cinnabar, all within eighteen leagues of St. Barbara. Thus at Azulcocha, one and a half leagues south of Santa Barbara, there is an extremely hard vein of cinnabar in limestone formerly mined, and where the ruins of old furnaces are still to be seen. The ore occurs in small branches and painted surfaces without regularity, and yields an average of not over one per cent. Near this is another vein of realgar containing also mercury, and about five feet in thickness. Immediately adjoining the realgar is a vein of a black sooty material of about eleven feet thickness. It appears to be a decomposed sulphuret, but its characters are obscure. This vein is remarkable from its containing selenium, associated with sulphur, mercury, arsenic, silver and lead.

The ores of Santa Barbara mine are all poor, not averaging probably over one-half of one per cent. The ore is frequently quite invisible and is disseminated through the rock at times in feebly developed veins a few lines in thickness, but generally without any vein form whatever. There are ores in the lower portions of the mine in which the cinnabar is invisible, but generally the appearance is that of common sandstone with very small particles of a bright red color scattered through its mass. Crosmin, a French engineer, describes the same stone as intimately mixed with arsenical pyrites. Such ore contains more mercury than the simple sandstone. As much realgar is found in the St. Barbara mine as in all the other quicksilver formations of Peru. The arsenical mercury ores were rejected by the miners, because of the effects of the arsenic in the furnaces. Sulphate of barytes both in crystals and closely mingled with siliceous grains occurs in the mine. Large quantities of iron pyrites are also found, much of which might no doubt be profitably worked.

The deposit of cinnabar at St. Barbara is not in a vein, as at New Almaden, but is disseminated through the strata, and intimately mingled with the sandstone. No walls exist, and the limits of the ore are irregular and undefined. Like all other similar formations the quantity of ore is very great and the quality very poor.

The furnaces used in reducing the ores were of stone and brick, poorly constructed, and the vapors were conducted through aludels or earthen jars joined end to end and leading from the upper part of the furnace, a distance of from eight to ten yards, where the smoke and vapor escape into the open air. These aludels are about two feet long, by a middle diameter of eight inches, and four inches at the ends. Four lines of them lead from each furnace, lying side by side upon the ground. The furnaces and condensers are of poor materials, the openings imperfectly closed, and the firing badly conducted, so that great losses of quicksilver occur and the workmen suffer from the poisonous vapors. The fuel is of dried grass and the dry dung of the Llama, both scarce and almost valueless as fuel, the quantity consumed to produce a feeble effect being very great. The country is completely without wood, except in a few deep ravines where some stunted bushes grow, worth about $20 a cord, equal to 145 Llama loads. None of it exceeds three-fourths of an inch in diameter. There is some turf, better in quality than the other fuels, but insufficient to maintain a large metallurgical operation. The author searched the country for ten leagues about Sta. Barbara for coal, but in vain. A very poor quality of bituminous slate exists in considerable quantity about nine leagues from Santa Barbara, but aside from its low quality, the distance of mountain roads precludes its use. The history of this mine shows extreme difficulty from the want of fuel, and even stoppages for several months at a time.

The author considers at length the questions of labor, quicksilver lost in reduction, and markets and transportation of quicksilver, giving much curious information of an economical nature, which our space excludes.

In conclusion, it appears that the St. Barbara district in Peru is extensive, the mercurialized sandstone being practically inexhaustible in quantity, but the grade of ore very low, not over one-half of one per cent, and the richest portions not averaging over 1½ per cent. The records of the mines have been very loosely kept, and offer no reliable data. The furnaces are remarkable for their worthlessness, which is still more true of the fuel. A system of concentration of the poor ores by machinery and water, which is in unlimited quantity, was proposed by Baron Nordenflycht, which deserves serious attention.

The labor at Sta. Barbara is necessarily Indian, and very inefficient, the extreme rarity of the air at an elevation of 14,975 feet above the sea (according to Ulloa) adding to the natural inefficiency of the race. Great numbers of Indians formerly were employed in these mines. In 1621, there were 2,000 Indians, who were required by government edict to produce 3 quintals (4 flasks) of quicksilver for each Indian per annum. "His majesty pays for the same, $47 per quintal." In 1681 the cost of quicksilver to the government, including transportation to Potosi, was $79 per quintal, and in 1678, its value at Potosi was $97 per quintal. In 1789 the cost rose to $195 per quintal, so that the king lost that year $197,758, and in five years, $693,624. In 1681, and for some years about that time, the average product was 7,500 flasks per annum, with 4,249 Indians at work. At New Almaden nearly six and a half times that quantity of quicksilver has been extracted in a single year by less than a thousand men. B. S.

ART. III.—*Notes on the Quicksilver mines of Almaden, Spain.* Condensed from a MSS. Report made to the New Almaden Company of California, by C. E. HAWLEY, M. E.

THESE mines, which, according to Pliny, were worked 700 B. C., and in his time annually sent 10,000 pounds of cinnabar to Rome,* are still productive to a remarkable extent.

The geological position of the Almaden mines has been shown to be Upper Silurian by the researches of Don Casiano de Prado, the predominating rocks being slates which usually form the walls of the veins and are sometimes impregnated with cinnabar. The matrix or gangue stone of the ore ground is a hard fine-grained sandstone, so hard at times as to be confounded with quartz. These sandstone beds form the so-called veins, and appear to have been impregnated with the vapors of cinnabar at the time of their metamorphosis, and so evenly are they charged with the ore, that in mining very little waste rock is taken out. There are three veins of ore at present worked in this mine. 1st, the San Diego and San Pedro; 2d, San Francisco; and 3d, San Nicholas. These are separated by masses of slate and sometimes enclose thin layers of slate in the ore. The linear extent of the mine is only about 600 feet, and near the surface, was much less. The mine is divided into ten different floors or levels, separate from each other by an average of about 90 feet, the lowest level being 921 feet from surface.

* Pliny, lib. 33, chap. 7.

The veins in the upper workings appear to have been very indistinctly defined, but have increased in power and in quality of ore steadily as greater depths have been reached. They were fully developed in their true character only on the 5th floor, while now in the bottom of the mine at the 10th level the richness and abundance of the ore in sight exceeds all before known. The following tabular statement illustrates this progressive increase in the extent and width of the three veins at the several levels commencing with the fifth.

	San Diego.		San Francisco.		San Nicholas.	
Level.	Length.	Width.	Length.	Width.	Length.	Width.
5th,	164′	14·5′	426′	13′	98′	9·6′
6th,	264	16·5	363	49·5	214·5	10·7
7th,	495	15·3	511	15·3	412	13·2
8th,	561	26·4	594	14·5	610	18·1
9th,	495	21·5	478	9·1	561	9·2

The 10th level is not yet sufficiently worked to determine the length or thickness of the veins, but the ore is of fine quality. The veins stand nearly vertical and are opened by vertical shafts. Their course is in general N.W. and S.E., and they are separated from each other by slate and sandstone. The linear extent of these veins is far from being completely proved. Work has been suspended where the ground became comparatively sterile. But it is well known that the mine, extensively opened in the 17th century by the Fugger Counts, exists in close proximity on the N.W., while a few yards of exploration in that direction, or to the S.E., may show the veins restored to their fruitfulness. The great mine worked by the Fuggers, and after them until the great fire of 1755, though in close proximity to the present mine, is now unknown, although the records prove its great yield and that it was worked to a depth of 825 feet.

The mode of extraction of the ore with the securing of the mine is by leaving alternate pillars of the solid ore 4 varas wide, the space left void between which, after the ore is removed, is filled by masonry, or by broken stones supported upon arches of masonry. The galleries of the mine are also turned in masonry. This system was adopted in 1804 on account of the scarcity of timber and with a view to the greater permanency of the work. The reserves of ore thus accumulated, equal nearly to all that has been removed, have been left untouched since 1804 until within the past 6 years, since which time very limited quantities of them have been removed, the spaces left being filled with much less care than the first set of pillars. Timber is used only for temporary purposes; the stone required for the masonry being quarried in the adjacent hills.

The mechanical appliances of this great mine are of the most primitive description. The ore is raised through the Teodoro shaft by 8 mules working a whim with an effective force of about 3 horses (steam standard). The amount of water in the mine is very small and appears to have varied but little in a century. The system of pumping is slow, expensive and barbarous. An antique machine of the last century, notable only for its age and inefficiency, demands for its aid the constant additional force of 30 to 40 men employed in pumping by hand.

The cost of extraction of the metric quintal of 100 lbs. of ore is as follows, given in reals (=5 cents U. S. coin.)

Excavation in ore and dead ground	7·40	reals	
Interior transportation	1·24	"	
New timber, refuse rock, etc.	0·55	"	
Tools, 0·92, whim, shops, etc., 1·17	2·09	"	
Rock for fortifying mine, 1·57 mortar and brick, 1·02,	2·59	"	
Masonry, 1·25, timbering, 3·67, carpentry, 1·11	6·03	"	
Draining the mine	4·47	"	
Laborers at mine, shaft, yard, etc.	2·86	"	
Various expenses, 0·78, salaries, 1·48	2·26	"	
			29·49
Transportation to furnaces,	0·17	"	
Cost of metric quintal of ore at furnace,			29·66

This is equal respectively to 67·8 c. and 68·2 c. of U. S. coin.

Much doubt seems to rest over the amount of metal obtained from the ore and respecting the relative merits of various modes of distillation. The most trustworthy observations, however, appear to be those made between 1851 and 1855, from which the average per centage obtained was 6·9, at the following cost per quintal (100 Spanish pounds.)

Mining and transportation	197·65	reals.
Cost of reduction in furnaces	22·35	"
Flasks	40·00	"
	260·00	

equals $13 U. S. coin per quintal, or $9.75 per flask, which sum is however raised to $15·15, including cost of transportation to Seville and various incidental expenses. The average product of the five years named for both Almaden and Almadenejas we find at 16,582 quintals (=22,199 flasks), which cost in the aggregate $304·535, or $13.77 per flask. If the expenses and product of the Almaden mine are estimated separately, (Almadenejas being a small mine, raises the ratio of cost considerably), it is seen that its average annual yield was 21,468 flasks, costing $268,214.53, or $12.49 in Seville. This cost is apportioned as follows.

Mining, per flask,	$6.53	or	52·25	per cent.
Reduction, "	0.87	"	6·96	"
Flasks, "	1.50	"	12	"
Flasking, "	0.09	"	0·75	"
Transportation to Seville,	.70	"	5·64	"
Administration,	2.58	"	20·65	"
Extraordinary, etc.,	.22	"	1·73	"
Total per flask,	12.49		100·00	

In the aggregate these expenses appear as follows, viz:

Administration,	$8,188
" superintendence, clerks, firemen, etc.,	21,117.80
Expense of warehouse at Seville,	2,459.50
Materials of shops,	1,121.85
Mining (less administration),	133,086.95
Reduction (furnaces),	17,544.20
Flasks, flasking and transportation,	39,951.70
Commission,	36,171.30
Transportation of funds, etc.,	1,880.55
Rents, $189.95, charities, $497,	684.95
Extraordinary and unforeseen,	4,687.75
Daily ordinary accts. of storehouses,	290.90
Hospital and church,	2,291.00
Laboratory, -	160.00
	$269,636.45
Deducting $2680·05, the profits of Almadenejas,	2,680.05
And the remainder of	$266,956.40

very closely corresponds with the sum of $268,214.55, the cost of 21,468 flasks at $12·49 each.

The Bustamente furnaces in use at Almaden are extremely defective, depending on a series of small earthen ware cylinders, joined one to another and leading into a large chamber for the condensation of the mercurial vapors. Much mercury is lost from leaks in the joints of this apparatus.

In 1856 extensive and careful assays were made by two engineers employed by the Spanish government, of the ores accumulated for the burning of that year. The following deduction was made of the value of the different qualities of ore.

Metal or superior mercury,	38·576
Mediano (medium)	9·9
Bolas (cakes) of fragments of soot from condenser,	17·790
Bolas without soot,	5.110

Applying these figures to the five years, the results would be as follows, viz:

38,551	quintals	"metal,"	=38·576 p. c.	= 14·872	quintals	mercury.
143,969	"	"mediano,"	= 9·904 "	=14·239	"	"
5,109·5	"	bolas with soot,	=17·79 "	= ·908	"	"
45,985·5	"	bolas without soot,	= 5·11 "	= 2·349	"	"
		Total quintals,		32·368		
		" " obtained,		16·101		
		Loss,		16·267.		

This loss of 50·25 per cent is equivalent to 21,689 flasks; or, the ore contained, by the above estimate, 13·86 per cent and the amount of mercury obtained was 6·96 per cent.

Notwithstanding the cheap labor at Almaden, many items of cost are extravagantly high; at 78 cts. per ton of water raised, the enormous sum of $17,541 is expended in pumping by hand! At least one-third the effective force of the mine-laborers is wasted in the toil of climbing up and down from the entrance to the bottom of the mine, want of ventilation making an additional heavy tax on the productive power of the miners. The cost of fuel for the furnace is extravagantly high and its quality the poorest.

The great feature of this mine, in contrast with other mercury mines, is the enormous body of rich ores always in reserve and ready for immediate extraction. A careful measurement shows that 36 per cent of the vein has been left untouched, equal to 2,012,600 cubic feet, which upon a moderate estimate must weigh 402,520,000 lbs. This at 7 per cent would give 375,685 flasks of quicksilver; at ten per cent it would yield 536,693 flasks, and at 14 per cent, 753,370 flasks of 75 pounds each. This estimate makes no account of the great body of extremely rich ores existing untouched between the 9th and 10th floors of the Almaden mine.

The very heavy expenses of fuel, pumping, transportation, hoisting of ores etc., might easily be reduced to at least one-half their present cost. Good coal exists in the great coal fields of Belmez, only 40 miles from the mine. With a safety cage for raising ore and the operators, good ventilation and drainage, and a proper system of railroads above and under-ground, the expense of many laborers might be saved. With these improvements and certain changes of administration, the author concludes that quicksilver can be produced at Almaden at a cost not exceeding one-third of that now incurred in the mines at New Almaden in California. B. S.

ART. IV.—*Extracts from the Address of* Sir RODERICK I. MURCHISON, *President of the Royal Geographical Society at the Anniversary meeting of the Society, May* 27, 1867.

AFRICA.—*Dr. Livingstone.*—During the last few months our thoughts have been directed with painful interest, to the last enterprise of our eminent associate, Livingstone. For reasons which I have explained at our evening meetings, and also through the public press, I have never admitted that there existed any valid proof whatever of the death of that great traveller. And now that Arab traders have arrived from a spot close to the reported scene of the murder, long after the event was said to have taken place, and brought to the Sultan of Zanzibar the intelligence that he had passed safely into the friendly Babisa country to the westward, and that a report has arrived at Zanzibar that a white man had reached the Lake Tanganyika, we have fresh grounds for hoping that he may now be pursuing his journey in the interior. In truth we have recently obtained good evidence of the mendacity of the man Moosa, on whose statement alone the death was reported—it being known that he has given one version of it to the Consul and Dr. Kirk at Zanzibar, and also to the British resident at Johana, and an entirely different one to the Sepoy examined, on his return to Bombay, by Colonel Rigby. We have, therefore, the strongest grounds for disbelieving the story altogether, and for hoping that our great traveller has passed safely through the intermediate country and reached the Lake Tanganyika, the great object of his mission.

Already Livingstone, by crossing the northern end of his own Lake Nyassa, has determined one important point in respect to the watershed of South Africa, for he has proved according to Dr. Kirk, that this great sheet of water here terminates, and is not connected with the more northerly Lake Tanganyika. If he has been spared, as we all hope, he has before him as grand a career as was ever laid out before an African explorer, it being now probable that Tanganyika, a fresh-water sea which must have an outlet, is connected on the north with the Albert Nyanza of Baker, and others belonging the Nile system. For although Burton and Speke estimated to the height of Lake Tanganyika to be little more than 1800 feet above the sea—the Albert, or lower lake being, according to Baker, 2720 feet—many persons, mistrusting the results obtained by the use of a bad thermometer, still think it probable that the Tanganyika may communicate through a gorge in the mountains at its northern end with the Albert Nyanza of Baker; for both these waters lie in the same meridian.

Pursuing this subject, our associate, Mr. Findlay, after a comparison of the altitude observations of Burton and Speke, on the first East African expedition, those of Speke and Grant on the second, and of Baker on his great journey to the Albert Nyanza, has prepared a memoir in which he endeavors to prove that these various altitudes are not inconsistent with Tanganyika being the furthermost lake of the Nile system, with an exit into Albert Nyanza. This important argumentative memoir will be read to us at our first meeting after the Anniversary.

For myself I give no opinion on a question which, like many others respecting African geography, can really be decided by positive survey only. Let us, then, trust that Livingstone has been enabled to solve this singularly interesting problem.

In the mean time not believing in the death of Livingstone on the sole testimony of one of his cowardly baggage-bearers who fled, and who has already given different versions of the catastrophe, I am sure the Society and the public will approve of the course I recommended, and in which I was cordially supported by the Council, and, to their great credit, by Her Majesty's Government, namely to send out a boat expedition to the head of Lake Nyassa, and thus ascertain the truth. If by this exhaustive search we ascertain that, sceptical as we are, the noble fellow did fall at that spot where the Johanna man said he was killed, why then, alas ! at our next anniversary, it will be the sad duty of your President, in mourning for his loss, to dwell upon the wondrous achievements of his life. If, on the contrary, we should learn from our own envoys, and not merely from Arab traders, that he has passed on into the interior (and this we shall ascertain in six or seven months), why then, trusting to the skill and indomitable pluck of Livingstone, we may feel assured that, among friendly Negro tribes, who know that he is their steadfast friend, he may still realize one of the grandest geographical triumphs of our era, the connexion of the great Tanganyika with the waters of the Nile system.

But even here I would have my countrymen who are accustomed to obtain [illegible] intelligence of distant travellers not to despair if they should be a year or more without any news of our undaunted friend. For, if he be alive, they must recollect that he has with him a small band only of faithful negroes, no one of whom could be spared to traverse the wide regions between Lake Tanganyika and the coast. Until he himself reappears—and how long was he unheard of in his first great traverse of Southern Africa !—we have, therefore, little chance of knowing the true result of his mission. But if, as I fervently pray, he should return to us, with what open arms will the country receive him ! and how rejoiced will your Presid be, if he lives, to preside over as grand a Livingstone festi as he did when this noble and lion-hearted traveller was ab to depart on his second great expedition.

The party which I have announced as about to proceed Eastern Africa to procure accurate information concerning L ingstone, will be commanded by Mr. E. D. Young, who did cellent service in the former Zambesi expedition, in the m agement of the *Lady Nyassa* river-boat. With him will associated Mr. Henry Faulkner, a young volunteer of gr promise, and two acclimatised men, one a mechanic and other a seaman. The expedition, I am happy to say, is warn supported by Her Majesty's Government, and the building the boat is rapidly progressing under the orders of the Bo of Admiralty. The boat will be a sailing one, made of st and built in pieces, no one of which will weigh more th 50 lbs., so that the portage of the whole by natives past cataracts of the Shiré will be much faciliated. The Gove ment have arranged for the transport of the party to the Ca with the boat and stores, by the African mail-steamer on 9th of next month.* Arrived there, one of our cruisers take them to the Luabo mouth of the Zambesi, where boat will be put together, and the party—having engage crew of negroes—will be left to pursue their noble and venturous errand, by the Zambesi and the Shiré, to the he of the Lake Nyassa. On account of the heavy seas which p vail on the western or leeward side of that lake, the expediti will keep close to its eastward shore, hitherto unexplored, a it is expected it will reach Kampunda, at the northern extre ity, by the end of October, and there ascertain whether great traveller has perished as reported, or has passed forw in safety through Cazembe to the Lake Tanganyika.

Senegal.—In former addresses I have had occasion to rec the great services rendered to Geography by the enlighte Governor of the French possessions on the Senegal, Colo Faidherbe, who has greatly extended [illegible] knowledge of country along the banks of that rive[illegible] most advan post of the French is Medine, near the c[illegible]ts of Felou, 6 miles from the mouth, up to which point the river is naviga during the rainy months, for vessels drawing 12 feet of wa With a view to ascertaining the political condition of countries beyond the eastern frontier, as also to fix accurat the geographical positions of places between the Upper Se gal and the Niger, an expedition was sent out by Colonel Faidherbe, in 1863, to traverse the distance between Medine and the important town of Segou, which had been visited by our own renowned traveller Mungo Park, sixty years previously. The mission was most ably and successfully carried out by Lieutenant E. Madge and Dr. Quintin of the French navy. Countries recently desolated by semi-religious wars carried on by Mussulman chiefs were traversed with great danger, and the positions of the route carefully laid down; the road taken being a *détour* to the north, after crossing the Senegal, by Diangounté, to Yamina, on the Niger, and thence by canoe to Segou. By this journey Lieutenant Madge has filled up a void in all maps of the region of the Upper Senegal, and corrected the positions of many places as previously laid down by Mungo Park and others; but the accuracy of our English traveller in the most important points is cheerfully acknowledged by his accomplished French successor, especially, for instance, in the position of Yamina, which Mungo Park fixed at 13° 15′, and Lieutenant Madge found to be 13° 17′ N. lat. The expedition returned to the mouth of the Senegal in June, 1866, and the French Geographical Society in the present year has rewarded the courageous leader with one of its gold medals.

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* To the credit of the Union Steam Packet Company the boat has been ta out free of charge. Whilst these pages are passing through the press, I l that the party sailed from Plymouth on the 11th instant.—*June* 12, 1867.

ASIA.—Whilst, with the exception of the probable settlement of the north end of Lake Nyassa by the last journey of Livingstone, little has been added in the past year to our stock of knowledge respecting Africa, much information has in the same period been elicited regarding the geography of Central Asia, particularly as respects the physical features of those vast northern portions of it which have been explored by the Russians, and the positions of places and mountain ranges laid down by our own surveyors to the north of British India.

At the head of the labors which have elucidated the comparative geography of this quarter of the globe, I place the two remarkable volumes produced by our distinguished associate Colonel Henry Yule, C.B., entitled "Cathay and the Way Thither," published by ou[illegible]ive auxiliaries, the members of the Hakluyt Society, and [illegible]hose productions our Secretary, Mr. Clements Markham [illegible] perspicuous editor. Although the student of the former condition of China and the surrounding regions has ever dwelt with profit and delight on the descriptions of the great traveller Marco Polo, as first brought under the notice of modern English readers by Marsden, and as since rendered so popular by the excellent work of M. Pauthier, it was left for Colonel Yule vastly to extend our acquaintance with the amount of information possessed by our ancestors in the mediæval centuries which succeeded to the epoc when the great Venetian lived. By gathering together in on collection various records of other travellers in the East, commencing with those of the quaint and original Friar Odoric c Pordenone, in the fourteenth century, Colonel Yule has no only satisfied the cravings of scholars, but has at the sam time gratified geographers by the preparation of a most instructive map of Asia, such as it was when explored by those earlie travellers, and when it was ruled over by the different branche of the family of Chinghiz Khan.

The contrast between the statistical and political condition of Asia, particularly its central portion, in those days when mercantile men traversed it freely from Azof or from Tabri to India and China, and the present time, when there exists so small an amount of land intercourse with Europe, is truly astonishing. In those days, and even as late as the sixteenth century, Samarkand, a city renowned as a seat of Mohammedan learning, was frequented by embassies, including one from the King of Spain. Even our own Queen Elizabeth was so anxious in the first year of her reign to open out an intercourse by way of the Caspian with Persia and India, that she addressed a letter to "the Great Sophi, Emperor of the Medes and Parthians." It was then (1558) that Jenkinson, our English traveller, made the journey from Astrachan to Bokhara, passing by Urghendj.

Now, with the exception of Russia, whose mission in 1841 has been noticed in previous addresses, no European power has had any sort of intercourse with the truculent Emir of Bokhara, to whom much of this fine region is, alas! subjected. It has since been left to stray travellers, one of the last of whom is the enterprising Hungarian Vámbéry, to explain to the civilized world the real state of this region, once so important, and now so fallen through tyranny and misgovernment. No one can have read that author's sketch of the condition of the natives in either of the Khannats of Khiva or Bokhara, without rejoicing that Russia [illegible] through the energy of her Government, at last brought [illegible] barbarians to respect the frontiers of an empire which ha[illegible]lished a safe line of communication between its own territories and those of China.

One of the most important statistical results of modern geographical research, and the employment of natural means to a great end, is the bringing into real use, for the first time in history, the River Jaxartes of the ancients (now called the Sy Daria), and navigating it with steamers from its mouth on the Sea of Aral for many hundred miles into Turkistan and Kokand. By this great feat, and by the erection of forts, Russia has established an entirely new and well-protected route between Europe and China, far to the north of that followed by travellers and merchants in the middle ages, which was from the south end of the Caspian.

England, holding as she does so high a maritime position among the nations, may reflect with satisfaction on her great eastern traffic with India and China carried on by her own great road, the ocean; and, far from envying the recent opening out of this land and river route through Central Asia, she may be well pleased that her northern allies should have a beneficial commercial traffic by caravans with those fertile regions of northwestern China, with which, in fact, we never have had any intercourse, but with whom the Russians have traded for ages, though always until now with more or less impediment, due to the forays of the intermediate wild people, and particularly the Kokandians. The two great empires of Russia and China seem, in fact, to be destined by nature to interchange commodities by land and river communications through Central Asia; and so long as the line of such commerce between them is separated, as it now is, from British India and its dependencies by mountainous, sterile and snowy regions, impassible by modern armies, there never can be the smallest ground of jealousy on the part of Britian.

On this head I was much gratified, at our very last meeting, in listening to the able memoir of Captain Sherard Osborn on the actual state of Chinese Tartary, an enormous region that has become, through the relaxation of the Chinese hold, "no man's land," and in hearing from the eloquent author, as well as from the commentators on his memoir, that, instead of any apprehension being entertained regarding the late Russian advances, it was generally felt that it would be greatly to the advantage of the natives, as well as to British power in India, that the influence of a civilized Christian nation should be extended eastward over a region now becoming desolate through misgovernment and lawlessness.*

These considerations lead me naturally to say a few words upon the geographical [illegible]tions of our medallist Admiral Boutakoff, which have [illegible]y led to the establishment of the new Russian line of e[illegible] traffic, and which have justly obtained for him a high reputation. The first of these enterprises might almost be called the geographical discovery of the

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* The reader who wishes to become acquainted with the physical features and boundaries of the districts of Chinese Tartary, so well expounded by Capt. Sherard Osborn, and of which he prepared a large map, must consult Keith Johnston's Library Map of Asia, published by Mr. Stanford, in the preparation of which, Mr. Trelawney Saunders took a leading part.

Aral Sea. For, although this great mass of salt water had been known to Arabian geographers during several centuries under the name of the Sea of Khwarezm, though its shores had been visited by travellers, one of whom was the accomplished Russian geographer George von Meyendorf, who described the mouths of the Syr Daria or Jaxartes, at its northeastern extremity, and another, General Berg,* who led a Russian expedition along its western banks in the winter of 1825–6, no ship had ever sailed upon this inland sea. The first vessel launched upon it was constructed at Orenburg in 1848, and transported in pieces across the desert, and in it Boutakoff, after two years of navigation, defined the real shape of the coast, established the depths of the sea, and was the discoverer of the large island in it, the wild antelopes of which came to stare with astonishment, yet without fear, at their first invaders.

Fifteen years have elapsed since I communicated the first important paper of Boutakoff to this Society, and it was spoken of with all the praise it merited in my Anniversary Address of the year 1853.† The successful exploration of the Jaxartes, and the discovery of its fitness for steam navigation, which was the next exploit of Boutakoff, led to the establishment of the great central route to China already mentioned, and Russia naturally availed herself of the commercial advantages thus presented in these natural features near the boundaries of her Asiatic possessions.

The question now arises, whether, by these enterprises, the honor does not truly belong to Russia, of having, for the first time in history, defined the course of the Syr Daria and its exit into the Sea of Aral? The classical writers were, as I shall presently show, ignorant of the true geography of this region, particularly of its northern part, and an attentive consideration of its geological structure and physical outlines has led me, followed by the inquiries I have made among comparative geographers who have well studied the subject, to believe that their silence with respect to the Aral Sea is no proof that it has not existed during the whole of the historical era.

Holding this opinion, I neces[illegible] differ from my friend Sir H. Rawlinson, who, in observati[illegible]ently delivered from the chair of this Society‡ made a ve[illegible]genious statement, and gave it as his opinion that there was sufficient evidence to show that in early times, say from 600 years before the Christian era to 500 or 600 years after it, both the river Oxus and Jaxartes flowed into the Caspian, the Aral being non-existent. That afterwards, and up to the year 1300, they fell into the Aral, and that for the next two hundred years (1300 to 1500) they came back into the Caspian, subsequently flowing gradually back into the Aral and forming the sea as we now know it.

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* See the first published notice of the remarkable expedition of General Berg in 1825, in the work of myself and coadjutors, "Russia and the Ural Mountains," vol. i, p. 310. General Berg is now Count de Berg, and the emperor's representative in Russian Poland.

† Journal Royal Geographical Society, vol. xxiii, President's Address, p. lxxxvi.

‡ See "Proceedings," Royal Geographi[illegible] Society, 11th March, 1867.

Although I know that my colleague will admit that my geological data must have some weight, I have to claim his indulgence for venturing to question the views of so eminent a scholar respecting the changes of physical features in this region that may have happened in the days of history. Supported, however, as I am by the opinions of men on whose knowledge I place great reliance, I must say that I cannot regard the Persian manuscript, which was presented to Sir Henry by a clever chief of Herat, to be a document of sufficient value to override the conclusions at which I have arrived on many independent grounds.

Concerning the ancient course of the Oxus, I see no reason to differ from the Persian writer and Sir Henry. But when it is stated that in the year A. D. 1417 the Jaxartes had deviated from its former course and instead of flowing into the Caspian (as the ancients had it,) joined the Oxus, and thus, the two rivers occupying one and the same bed, came into that sea, I must withhold my assent. This is a novel and striking statement, and before we attach credence to it we must have some physical evidence to sustain it. In my state of scepticism regarding the value of this Persian manuscript, now for the first time produced, that which strikes me *à priori* as a sign of its invalidity, is, that when this region was open to knowledge through the long-enduring reign of the civilized and literary Arabians (say from the 7th to the 13th century), the Aral was known and laid down as a distinct water-basin under the name of Sea of Khwarezm. On the other hand, when after that period knowledge became dim and local, and civilization was at its lowest ebb, then it was that the Aral disappeared. My conclusion from this coincidence of the supposed emptying of the Aral, with th[illegible]bsence of records respecting it, would be that the sea h[illegible]xisted during all that time, but that there were then no [illegible]graphers to record the fact.

In treating this subject, let us first consider the separation of the Aral from the Caspian as originally dependent on geological changes of the surface, and then proceed to estimate the value we are to attach to the writings of the classical authorities in reference to a region so very imperfectly known to them. As a geologist who has studied this Aralo-Caspian question *in situ* I beg to place on record in our geographical volumes my view of the pre-historic physical outlines of a region which, with the exception of the obliteration of one mouth of the Oxus, has, I venture to think, undergone no essential change during the human period.

According to all good authorities, including Humboldt, there existed in the latest tertiary, or what some call quaternary times, a vast depression on the surface of the globe, extending over 8,000 square marine leagues, in which a great inland sea was accumulated, and which, in a work on Russia, my associates and myself first mapped out under Humboldt's name of Aralo-Caspian.* In that sea there lived an abundance of molluscous and other animals, all of species having a local and limited range, and all strikingly distinguished from the more numerous animals of oceanic seas. Now, owing to the upheaval of large portions of the bottom of that old inland sea, its animal contents formed, in a fossil state, the Steppe limestone, are seen at different levels over an enormous area. Owing to these pre-historic movements of the crust of the earth, these fossil remains are seen to occupy the strata on the banks of the lake of Aral, as well as on the shores of the Caspian Sea. They also occur at various places and at different heights in the adjacent Steppes, extending westward to the country of the Don Cossacks to the north of the Sea of Azof, where I have myself examined them. There is therefore no doubt that, in pre-historic times, the Aral and the Caspian, and also portions of a much wider region, now raised above them, were occupied by one vast internal and depressed sea, large portions of which have been desiccated. By these movements of elevation that part of the former great sea which became the Aral was elevated to about 117 ft. above the former western part, or present Caspian, and the seas thus insulated were separated through the same movements by the elevated plateau now called Ust-Urt.

This was the physical condition of the region long before tradition or history. Humboldt has well remarked that the great Aralo-Caspian depression had a similar origin to the much deeper cavity in the earth's surfa[illegible]ccupied by the Dead Sea, though the one is only 83 feet an[illegible] other nearly 1300 feet beneath the Ocean. Now, if we endeavor to account theoretically for the low present level of the old Aralo-Caspian Sea by evaporation only, we are met by the facts that large portions of its former bottom have been raised to different altitudes in the surrounding region, and that the levels of the Sea of Aral and the Caspian are also different, and are separated by the great plateau of Ust-Urt. As it is impossible to explain the existence of the much deeper cavity of the Dead Sea except by a greater sinking of the earth's crust, so is such a phenomenon precisely what geologists would expect to see realized as a natural and compensating result of the corresponding upheaval of the adjacent lofty mountains of Asia.

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* See 'Russia in Europe and the Ural Mountains,' vol. i, pp. 303–314, and particularly observe the map and section, p. 311, from the Sea of Azof across the Caspian and the Ust-Urt to the Sea of Aral.

This being the conclusion at which geologists have arrived, let us see if it be interfered with by any reliable historical records. As to the knowledge possessed by Alexander, or his contemporaries, it really does not touch the question of the relative courses of the Oxus and Jaxartes toward their mouths. For Alexander crossed the Oxus at about 400 miles above its mouth, and the most western point at which the great conqueror reached the Jaxartes was Cyropolis, where he passed it to defeat the Scythians ; and that spot is about equidistant from the Aral Sea. Consequently, neither Alexander nor his generals could know anything of the real course of either river for great distances above their mouths. Scholars and comparative geographers doubt, indeed, if any weight can be attached to the unanimous statement of the Greeks, that both the Oxus and Jaxartes flowed into the Caspian, by mouths some 300 miles apart,[*] when they see how equally unanimous were the writers who came between Herodotus and Ptolemy in believing the Caspian to be but a gulf of the Northern Ocean! Again, we see how persistently the followers of Alexander confounded the Jaxartes itself with the Tanais, and fancied that they had doubled back upon the rear of Europe.

"The expedition of Alexander," says Humboldt, "far from extending or rectifying the geography of the Caspian Sea, confounded the Tanais with Jaxartes, and the Caucasus with the Paropamisus or Hindu Kush."[†] Again, "It is through a singular combination of circumstances that the great Macedonian expedition, which in other respects extended the geographical horizon of the Western nations, became fatal to the geography of the Caspian Sea."[‡] Further on, he says, "Some traces of the Sea of Aral, described as a great basin to the east of the Ural or Jaike River, are indeed found in Menander, the Byzantine historiographer; but it is only with the series of Arabian geographers, at the head of whom, in the tenth century, we must place El-Istachry, that we first obtain a certain knowledge of the topography of the countries."[§]

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[*] 2400 stadia according to Eratosthenes, and 80 parasangs according to Patroclus, both quoted by Strabo.

[†] 'Asie Centrale,' vol. ii, p. 14. [‡] Ibid., p. 153. [§] Ibid., p. 156.

The truth is, that, when it was thus loosely said, that both the Oxus and Jaxartes flowed into the Caspian, we must make due allowance for the ignorance of the ancients of the northern portion of this vast region, particularly of the course of the Jaxartes, which no one of them had fully explored, and at the mouth of which none of them had arrived.

If, indeed, we rely on the sagacious Rennell, he, in his great work on the 'Geographical System of Herodotus,' may be said to have established this point, for, in speaking of the old geographers, he says, "they understood the *Aral to be included in the Caspian*, since they knew of but one expanse of water in that quarter; for the Cyrus and Araxes, Oxus and Jaxartes, were all supposed to fall into the same sea." This he contrasts with the accurate subsequent knowledge of the Arabian geographers. And truly so, for this was the regular progress of observation, and a great advance over the ignorance of the classical writers respecting these hyperborean tracts. In those times the regions inhabited by the Massagatæ and the King of Khrasmia (the present Khiva) were barbarous countries, never explored by geographers; and, consequently, the classical authorities could only have obtained the little knowledge they possessed from native hearsay.

In his able essay on the 'Life of Alexander the Great,' Williams distinctly lays down, in his map of that period, the seas of the Aral and Caspian as distinct bodies of water. The same separation is given by Rennell, in his map of the twenty satrapies of Darius Hystaspes; and, whilst in it he indicates the Oxus flowing into the Caspian, and the Jaxartes into the Aral, he shows completely how the two seas were separated by what he terms the high plateau of Samob, the Ust-Urt of the present day.

Again, Thirlwall, in his 'History of Greece,' plainly leads us to believe that the Greeks could have known nothing of the region of the Sea of Aral and the mouth of the Jaxartes, except what they derived from the reports of the King of Kharasmia, who came from a distance in the north to visit Alexander. In short, there is no historical evidence whatever to to oppose the view, that the outline and structure of the Aralo-Caspian region, as now seen, was determined, as I have said, long anterior to the historical era.

On the point of the prehistoric separation of the Aral from the Caspian, I entirely concur with Humboldt. "If we ascend," he says, "to the primitive condition of the vast Mediterranean concavity, I should be led to believe that notwithstanding the diminution of surface which the Caspian and Aral basins may have undergone in the historical times, from

Hecatæus and Herodotus down to the tenth century of our era—*i. e.* to the days of the Arab geographers El-Istachry and Ebn Haukal—the event of the separation of the Aral and Caspian remounts to a geological epoch, which like the separation of the Euxine and the Caspian, or the opening out of the Dardanelles and Straits of Gibralter, are all ante-historical, or far beyond any human tradition."*

In sustaining this view it is to be remarked that, whilst the Aral Sea trends from north to south, the Syr Daria and its embrachment the Kuvan Daria, which flow into it from the east, have had courses at right angles to that sea itself; thus favoring the geological view that the great movement which produced the plateau of the Ust-Urt, separated the Sea of Aral from the Caspian, and left the chasm occupied by the Aral, was also accompanied (as is usual in such elevations) by transverse flanking openings in the mainland on the east, along which those rivers flowed. In this view the parallelism of the Syr Daria to that of the Kuvan Daria, about [illegible] miles south of it, is remarkable.

If the Jaxartes ever flowed to the southwest, as suggested by Sir H. Rawlinson, it must have joined the Oxus long before the united streams fell into the Caspian, which is very distant from the nearest point of the valley of the Oxus. But if such an union of the great streams ever existed in so southern a latitude, it must have been perfectly well known to the ancients, and they have made no allusion to it. On the contrary, they believed and have stated, that the rivers fell independently into the Caspian, and by different courses, separated from each other by a wide interval.

Whilst I think that, probably, the many-mouthed Oxus always sent a large portion of its waters into the Aral, I also quite believe that one of the branches debouched formerly into the Caspian, as explained by Humboldt, and as proved indeed by the old English traveller Jenkinson, to whom he refers. It will also be presently seen that the distinguished Asiatic geographer Semenof would explain the desiccation of the former or Caspian branch of the Oxus in another manner. The stoppage of that watercourse (formerly an usual line of traffic) may also be accounted for by a local elevation of land in that latitude; for it is not remote from the scene of igneous eruptions that produced volcanic mountains, as the greater and lesser Balkan, near the ancient desiccated mouth of the Oxus. Such a change of level may, indeed, have been caused by the same subterranean forces which, in this latitude, evolve, at the present day, the fires of Baku, and have recently thrown up volcanic mud-islands near the southern end of the Caspian. The elevating effect of these forces would deflect the Caspian branch of the Oxus and cause its waters to unite with the branches which flowed northward into the Aral Sea.

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* Humboldt, 'Asie Centrale,' vol. ii, p. 146.

The great distinction between the views taken by Sir Henry Rawlinson and myself is, that whilst I believe the main outlines of the Aralo-Caspian region were determined by movements of the earth in quaternary or later tertiary times, he refers the great changes which he believes to have been made in the courses of the Oxus and Jaxartes to no very distant historical dates; thus referring the emptying and refilling of the deep hollow in which the Aral Sea lies to comparatively modern times.

He offers, indeed, one argument, which, if sustained, would at once dispose of my view. In support of the opinion that the Aral sea was non-existent in the thirteenth and fourteenth centuries, he states that in those days travellers from Europe to Asia passed over dry lands since occupied by that sea. If this were substantiated, the belief I have adopted that the separation of the Aral from the Caspian, and the upheaval of the broad intervening plateau of the Ust-Urt, would be at once removed from a prehistoric period to the days of Henry III, and the two first Edwards of English history.

Now, surely, if so great a terrestrial change of surface as this had happened in the thirteenth or fourteenth centuries, the rumor of it would have been bruited throughout Europe and Asia. Unwilling, however, to rest upon any notions of my own, I have consulted that admirable comparative geographer, Colonel Yule, as to the routes taken by the mediæval travellers of that date; and he having favored me with much information respecting the whole of this subject, I extract from his letter the appended long note.[*] By reference to it the reader will see that no foundation for such an assertion is to be traced in the narratives of these old travellers. For even when the starting point of their journey eastward lay upon the Volga, their line of march is traced either quite to the south of the Aral through the lands of modern Khiva, or more to the north of that sea, and probably beyond sight even of its shores.

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[*] After alluding to the little weight to be attached to the statements of the Greeks, tracing the imperfect accounts of Herodotus and his followers, and rejecting the Oxiana Palus of Ptolemy, which had been made "to do duty," as he says, for the Aral on many respectable maps, Colonel Yule proceeds to say:—

"We are on surer ground in the narrative of the Embassy of Zemarchus to the Khan of the Turks about the year 570. The remains of the historian Menander, which relate this mission, are unfortunately but fragments, and do not say how Zemarchus got from Byzantium to Central Asia. But on his return route, which lay to the north of the Caspian we are told that before reaching the rivers *Ich* and *Daich* (apparently the modern Emba and Ural)[1] he passed for twelve days along the sandy margin of a certain *great and wide lagoon*. This looks very like the Aral; nor probably will Sir Henry Rawlinson deny its existence at that date. But I quote the allusion to show that even the Greeks, once they get actually to the site of the Aral, did recognize its existence.

"We now get to a period regarding which there is no controversy. A long

[1] "Perhaps, however, the *Ural* and *Ik*, so carrying the route north of Orenburg."

catena of geographical works, as Sir Henry Rawlinson tells us, represents the two great rivers as falling into the Sea of Khwarezm, *i. e.* the Aral. But is it the case that this chain of testimony ceases with the year 1300? Among those quoted by Humboldt even are some of later date, such as Abulfeda and the Persian Hamdallah. It is the case, no doubt that those Eastern geographers often copy what has been said by their predecessors centuries before; but a passage which Humboldt quotes from Hamdalla, a writer of the 14th century, appears to be original. It speaks of the Sea of Khwarezm (or Aral) as having a compass of 100 parasangs, and separated from the Caspian by a tract of 100 parasangs in width. It contains also the remarkable statement that only a *part* of the water of the Oxus then flowed into the said sea, which was fed also by the River of Ferghana (the Jaxartes) and others.

"Two centuries later, when the first English traveller[1] reaches those regions, he finds the Aral in existence, though his account of it is but hazy; and when Russian geography springs up at the end of the 16th century, we find that it already knows the Aral well as the Blue Sea.[2]

"Knowing then, as we do, how many indications point to the existence in those regions in recent geological times of a great inland sea, and finding a tolerable chain of evidence as to the Aral itself—either positive or implicit—down to the days of modern geography, I feel it difficult to believe, on the authority of the Persian MS., that this great sea, nearly 600 miles in circuit, with precipitous sides and attaining a depth of 37 fathoms, did, for a number of years, entirely cease to exist, and then again became as we see it and as old Arab geographers had described it. I by no means desire to dispute that there may have been a material contraction of its area at the time when a considerable part, if not the main stream, of the Oxus flowed into the Caspian; but this is a different thing from its entire disappearance and desiccation.

"There is one argument on this subject urged by Sir Henry Rawlinson which I think a review of the facts in detail will scarcely bear out. He refers to that period during the 13th and 14th centuries when the vast extent of the Mongol domination threw open Asia, which for a succession of years was penetrated by envoys, missionaries, and adveuturers, several of whose narratives have come down to us, and when a regular course of trade was established, regarding which we have many particulars.[3] The route usually followed by those travellers, Sir Henry says, lay exactly across the site of the Sea of Aral; yet not one of them mentions it. If this were so indeed, it would be vain to maintain the *improbability* of what would be so clearly established as a fact.

"But let us glance at the routes followed by these travellers successively from the first of them in the middle of the 13th century. This was Friar John of Plano Carpini, sent on a mission from the Pope to the great Khan in 1245–47. Friar John, though he writes in the main like a man of sense and reading, is not a good geographer. He makes the Dneiper, the Don, the Wolga, and the Jaic all fall into

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[1] "Jenkinson."

[2] "See in Levchine's 'Description des hordes et des Steppes des Khirghiz Kazaks,' in his dissertation on the Jaxartes, p. 462, a quotation from a Russian geographical work of the time named."

[3] "Surely there is a *lapsus*, when Sir Henry Rawlinson speaks of these merchants as returning with the *tea* and silk of China; or, if he has grounds for including the former, it would be most interesting that they should be produced. In 'Cathay,' I have indicated the mention of tea by Ramusio's Persian friend Hajji Mahomed, as the first known to me in any European book.

In considering what changes have or may have occurred within the historic period, and quite independent of all former or geological changes, I necessarily attach great weight to the opinion I have recently obtained through my friend General Helmersen from M. P. Semenof, the President of the Physico-Geographical section of the Russian Geographical Society, who has distinguished himself by his researches in the Thian Shan

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the *Great Sea*, the '*Mare Magnum*, which has its issue by St. Georg's Channel at Constantinople;' and rides for many days along the shores of the Caspian, apparently under the impression that it is but a part of the Euxine.[1] We might ask, in passing, if there were no Friar Johns among the ancients capable of the more venial error of confounding the Sea of Aral with the Caspian? Be this as it may, there is no reason for carrying the route of Carpini's party over the bed of the Aral. After crossing the Jaic, it lay for many days through the land of the *Cangitæ*, or Kankhlis, in which they found few people, but very many and large salt-marshes and lagoons, which they took to be the *Paludes Mæotides* of the ancients, and which probably were those which still exist to the north and northeast of the Aral.[2] They then enter the land of the *Bisermini*, or Mussulmans, and come upon the cities and cultivated lands of northern Turkestan.

"Friar William de Rubruquis, eight years later, is more correct in his notions of geography, He clearly discriminates the Caspian from the Euxine, and gives a fair account of it. He gives also the general orientation of his route, running due east from Wolga for 45 days and then turning southward, and so continuing for eight days till he reached *Kenchak*, a city known to have been in the valley of the river Talas. If you protract this route as well as the data will admit, you will find that it entirely clears the Aral.[3]

"Another traveller, who visited the court of Mongolia in the same year with Rubruquis, was King Hethum or Hayton, of little Armenia. He, too, after visiting Batu Khan upon the Wolga, rides eastward across the Jaic; but, as he passes the Irtish also, his route must have lain far to the north of the Aral. On his return he passed by Samarkand and Bokhara into Persia.

"Marco Polo himself never mentions the Aral, indeed; but neither does he mention the Jaxartes, and seems never to have been nearer either than at Kashgar. In the preliminary chapters of his book, in which he speaks of the journey made by his father and uncle from the Wolga to Bokhara, he unfortunately gives no particulars of their route,[4] excepting that they went south from Bolghar to Ukak (near Saratov) before striking east.[5]

"Probably, however, it was the same as that laid down in the next century from the information of the merchants who had travelled it, by the Florentine factor Balducci Pegolotti, about 1330–1340. This route, followed by mercantile travellers bound for China, ran from Sarai, on the Wolga, to Saracanco, or Saraichik, on the Jaic, and thence in camel-waggons to Urghanj, the capital of Khwarezm, which stood on a branch of the Oxus, about 60 miles south of the present embouchure of that river in the Aral Sea. From Urghanj the travellers were in the habit of proceeding to Otrar, a few miles north of the Jaxartes, and not far from the modern town of Turkestan, and so forward to the Almalik, near

[1] "See in D'Avezac's edition, p. 743."

[2] "See the narrative of Carpini's companion, Benedict the Pole, in D'Avezac, p. 777."

[3] "For a detailed examination of Friar William's route see 'Cathy and the Way Thither,' p. ccxi, *seqq.*"

[4] "The *Tigeri*, or Tigris River which Polo mentions as crossed by the party, was supposed by Marsden and his successors to be the Jaxartes; but Pauthier has clearly shown it to be the Wolga. (See his 'Polo' p. 8; also Cathay,' p. 234.)"

[5] Timur, invading Kipchak and Russia, went so far north as to cross the Tobol before crossing the Jaic.

chain of Central Asia. Whilst he rejects, like myself, the hypothesis of the great Aral depression having been emptied and refilled in the historical period, he refers the desiccation of the Asiatic rivers and the diminution of lakes to the decrease of glaciers in the high mountains, as well as to great evaporation. By these causes he thinks that at one period the Aral Sea may

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the Ili, the capital of the Khanate of Chagatai. They thus travelled distinctly *round* and not across the bed of the Aral. We are told, indeed, that if they had no merchandise to dispose of at Urghanj, they might save from 5 to 10 days by going direct from Saraichik to Otrar. If we lay down this direct route with geometrical and literal directness, it will indeed pass through the extreme north of the Sea of Aral. But even direct railway lines are not so straight as that; and there can be little doubt that Pegolotti's direct line was much the same as that followed by Carpini and Rubruquis in the preceding century.

"The same route that Pegolotti recommends—viz., that from Sarai to Saraichik, and thence to Urghanj and Almalik—was followed by Friar Pascal, of Vittoria, in 1337,[1] (and as far as Urghanj) by Ibn Batuta, a few years earlier, in travelling from Sarai to Bokhara.

"It was probably also the route followed by John de'Marignolli, on his journey toward Peking, in 1339–42; but unfortunately, he says nothing whatever of his route between the two Mongol capitals of Sarai and Almalik.

"We have named all the travellers, as far as I am aware, that have left any record of their journeys in those regions during the period to which Sir Henry referred. None of them, we must acknowledge, say anything of the Aral Sea; but we see also that it cannot be maintained that they gave the practical disproof of its existence which would be afforded by their travelling dryshod across its bed! and the travellers' narratives were the bases of the maps to which Sir Henry has referred. The Catalan map does not, indeed, contain the Sea of Aral; but neither does it contain any hint of the Jaxartes. The great map of Fra Mauro, though it contains no Aral, represents the river Amu (or Oxus) as flowing into the Lake Issik-kul, which is, perhaps, an adumbration of some knowledge of its discharge into another sea than the Caspian. The traditions of geographers are hard to correct. I do not know what map first shows the Aral under anything like its proper conditions. Many years after the date of the Russian geography to which we have alluded as so clearly indicating the Aral under the name of the Blue Sea, we find John Blaeu, in his great Atlas (1663), representing the Jaxartes as flowing into the Caspian, and a duplicate of the same river, under the name of *Sur*, flowing by Tashkend into the 'Lake of Kathay,' with a difference of 30 degrees of longitude between the two! Even Petis de la Croix, in the maps (sometimes singularly happy) which illustrate his translation of the History of Timur, has no indication of the Aral.

"There is, indeed, one mediæval map which at first sight seems to bear strong testimony to the existence of the Aral Sea in the beginning of the 14th century. I mean that curious one executed by the old Venetion Marino Sanudo, and submitted by him to the Pope and King of France, about 1325, with his grand scheme for the destruction of the Mohammedan power. This map exhibits very clearly a *Mare Yrcanum Caspis* or *de Sara*, in the proper position of the Caspian. It is connected by a river with another sea, further east, marked *Mare Caspium*, and full of Islands, which is in a startling degree suggestive of the Aral. Further still to the east, toward *Sera*, appears a third and smaller sea, without a name, into which the *Gyon* flows (*i. e.* Jihun or Oxus). I dare not, however, lay much stress on this map, which contains almost nothing else to corroborate a claim to exacter information. The multiplied seas *may* have sprung only out of some misunderstanding of the classical geographers."[2]

[1] "'Cathay,' p. 232."

[2] "The map is engraved in 'Bongarsius, Gesta Dei per Francos,' vol. ii. There is a *quasi* facsimile of it in the second volume of Vincent; but in this latter the third sea is scarcely to be recognized."

have been diminished, though he is firmly of opinion that such a deep depression could not have been emptied and refilled. In reference, however, to the former Caspian branch of the Oxus, in the existence of which he believes, he supposes that many streams, now dry or nearly so, formerly augmented the volume of the Oxus, thus enabling it to supply a branch to the Caspian by the Gulf of Karabogas, and that to the failure of this supply we may attribute the drying up of the branch, without involving any great physical change of outline of the land. In this case the Aral Sea, occupying a separate cavity not communicating with the larger depression, would, as he thinks, become shallower, and to a great extent obscured by reeds, so as to have remained unknown to travellers for 500 years before and 500 years after Christ. M. Semenof suggests that in those days when the southwestern branch of the Oxus existed, travellers proceeding northward and meeting with little but reeds and marshes, might very well suppose that the Aral was merely an extension of the great Bay of Karabogas of the Caspian Sea. In illustration of this view he informs me that the inhabitants around the lakes Ala Kul and Sassyk-Kul have at this day no precise conception of their separation, and term them both Ala Kul simply, because they are unacquainted with the marshy and inaccessible isthmus between them. In Central Asia, too, the River Tchu, through its desiccation, has lost its former communication with the Lake Issyk-Kul, just as in the Aralo-Caspian region the Sary-su River has failed to reach Syr Daria; and this last river, having lost its northern affluents, could no longer contribute (if ever it did) by any of its branches to the Oxus, and has found an easier embouchure in the Aral. How easily these changes of direction are effected in the course of rivers in flat and sandy countries is well known to many Russian geographers who have explored Central Asia.

Thus, the Oxus, deprived of many of its former affluents, ceased to be able to throw any portion of its waters into the Caspian, and took the straight course into the Aral. This natural operation, as Semenof observes, may have also been accomplished within the historical period, and so, since its southwestern or Caspian branch dried up, the Oxus, by throwing all, instead of a part, of its waters into the Aral, has given to that sea a better marked place in human knowledge than it had in the fourteenth and fifteenth centuries.

Before I quit the subject of the now desiccated former branch of the Oxus I may state, on the authority of my correspondent, General Helmersen, that recently a memoir was presented to the Imperial Geographical Society of St. Petersburg, suggesting that men of science should be sent to the spot to examine into the evidences of that ancient bed of the river, and also to test, by soundings along the shore of the Caspian, if any remains of the old delta of that stream could be detected. But the project, as well as the continuation of the survey and soundings of the southern edges of the Caspian, have both been suspended, I believe from motives of economy. The latter important work was under the able direction of Captains Ivanchnizow and Oulsky, who had already proceeded so far that in less than three years they would have completed the survey of the whole of that vast interior sea; and it is indeed much to be regretted that a work of such great geographical interest should have thus been set aside.

In conclusion, my belief is:—1. That the Caspian and Aral have existed as separate seas before and during all the historic period. 2. That the main course of the rivers Jaxartes and Oxus, as also of the sites of the Caspian and Aral seas, were determined in a prehistoric period. 3. That at one time the Oxus emptied itself both into the Caspian and the Aral, and that the Caspian branch-stream was sent back to the course of the other portion of the stream, either by the local rise of some lands between Khiva and the Caspian, or by desiccation and a want of sufficient power of water. And, lastly, that the Jaxartes never was deflected from its natural east to west course, to pass southward, and so reach the Caspian by the southern end of the great elevation of the Ust-Urt, after a very long course at right angles to its present direction, to say nothing of its having in that case necessarily united with the Oxus by the way—a fact, of which, as already stated, all history is silent.

If old authors believed, without personal observation, that the Jaxartes, as well as the Oxus fell independently into what they called the Caspian, we may easily account for such a notion, at a time when the true meridian of barbarous places lying to the north of any line of intercourse between Greece or Rome and Asia was wholly undetermined. May we not rationally infer that the ancient geographers believed that the Jaxartes, as well as the Oxus, flowed into the Caspian, simply, as suggested by Rennell, from having heard that the Jaxartes terminated in one great sea, and that they naturally believed that the Aral was then simply the northeastern portion of those large inland waters of which they had heard, but of which they knew nothing accurately.

In truth, when we know that the geography of the Greeks, and even of the Romans, was worthless, in regard to any lands beyond the parallel of the mouth of the Oxus, we necessarily recur to the works of the earliest Arabian geographers, in which the Sea of Khwarezm was first exhibited as a separate sea. As such it also appears in the maps of Rennell, of Williams, of Yule, and, in short, of all the best authorities, representing that which I believe to have been the true physical condition of the region during all historical time, and which I maintain dated from an ante-historical period.

In estimating the present or future relative importance of the Oxus and Jaxartes as lines of commercial traffic with China and India, I have no hesitation in saying that the latter river holds the first place. By reference to the memoir of Lieut. Wood, in the tenth volume of our "Journal," describing the sources of the Oxus, and still better by inspecting the map of the Bolor Mountains and Upper Sources of the Oxus, which has just appeared in our present volume (vol. 36), I agree with the able Russian geographer Veniukof, who, after alluding to the wild barbarian races which occupy the high tableland of Pamir and the adjacent mountains, adds this significant passage: "When we, moreover, remember that this basin of the sources of the Oxus is closed in on the north, east, and south by mountains from 15,000 to 18,000 feet high, and across which the roads for pack-animals are few and difficult to traverse, we must arrive at the conclusion, that all idea of converting this region into a rich entrepot for a trade with India and China must be abandoned."*

Before I quit the subject of the investigation of Central Asia, let me ask those of my countrymen who read German with facility, to peruse the great work of Ritter, the "Erdkunde von Asien;" and they will at once learn how to value the vast amount of modern discovery which is due to our Russian cotemporaries.

On former occasions I have naturally adverted to several of these remarkable researches; but I regret that, in my last two Addresses, I have omitted to notice, as I now do with special approbation, the memoir of M. Semenof, published in our Thirty-fifth Volume, on "Djungaria and the Celestial Mountains." As the only man of modern times who has explored a considerable portion of the Thian-Shan or Celestial Range, M. Semenof must be placed among the most distinguished of the famous band of Russian explorers—not simply for having determined many geographical positions, the forms of land and their altitudes, but also for his careful examination of the mineral character of the rocks which constitute the loftiest masses of those regions. In so doing, he has set aside one of the few errors which the illustrious Humboldt fell into in his grand generalizations, when he was led to believe that the Thian-Shan—the great axial range of Central Asia—must be essentially one of volcanic eruption.

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* "Journal of the Royal Geographical Society," vol. xxxvi, p. 263.

Influenced, doubtless, by his successful description of the Andes of South America, and the rise to their summits of active volcanoes, the great traveller was very naturally disposed to apply the same inference to the lofty chains of Central Asia; the more so as all the imperfect data he could collect seemed to indicate the existence of rocks of that class.

But as soon as the Thian-Shan was examined by the only man of science in our age who has visited it, he found nothing but sedimentary strata; and as this important rectification is due to M. Semenof alone, we must not only accord to him all due praise as a geographer, but it is specially my duty as a geologist to thank him for making this great observation.

In fact, the grand movements of upheaval, which determined the form of many of the loftiest mountains, whether in Central Asia or in the great northern barrier of India, the Himalayas, were caused by former expansions from the interior, doubtless due to the central heat, which raised up sea-bottoms, often altering them into crystallized rocks, and elevating them to enormous altitudes, without exhibiting any true igneous rocks.

Having already twice alluded to the recent discoveries in Asia by the Russians, and we having endeavored to do honor to them by the award of our Founder's Medal to one of the most distinguished Russian explorers, it is now my pleasing duty to advert to others of their recent labors in that quarter of the globe.

On former occasions I have dwelt upon the explorations of Eastern Siberia and the affluents of the grand River Amur and the mountains to the north. Let us now turn to Central Asia proper, and see what good documents have been furnished by the different men of science who have explored those regions. I gather from the bulletins of the Imperial Geographical Society that the communications of MM. Semenof, Severtzof, Poltarazky, Abramof, Bakkof, Goloubef, and Printz, explain the physical conformation of tracts and the natural riches of regions never before reached in modern times.

Of most of these hitherto unknown wild tracts the Russian explorers have prepared or are preparing maps. To faciliate journeys from Siberia to Pekin, Dr. Brettschneider, the physician to the Russian mission in China, has laid down upon a map all the different known roads across Mongolia, of which that which is called the post road is 1760 versts long, between Kiachta and Pekin, with 68 relays. If the telegraph, which one of our countrymen, Mr. Gordon, who had travelled across this desert, sought to realize, be established, the journey across the desert of Gobi will soon be thought nothing of.

As to Bokhara, of which Englishmen have only painful recollections, on account of the murder of our distinguished officers, Conolly and Stoddart, we now know that two Russians, MM. Gloukovsky and Tatarinof, who were for seven months captives there, have added much knowledge to that acquired by their accomplished countrymen Khanikoff and Lehmann in 1842.

Those of our associates who may now visit St. Petersburg may see pictorial views of Khodjend, Tashkend, and all the places taken from the Kokandians in the recent advance of the Russians along the Syr Daria and now forming parts of the great new province of Turkestan. I learn also, in reference to this region, so recently opened out to the civilized world, that M. Struve, the son of the great Russian astronomer, has prepared a map of the whole province of Turkestan, on a scale of 40 versts to the inch.

Deeply interested as we must all be in this grand opening out to geographers of a vast unknown country, my first request to my eminent friend Admiral Count Lütke must be, that as President of the Imperial Geographical Society and also of the Imperial Academy, he will procure for our Society copies of the maps which, to their great credit, the Russian geographers have prepared.

ART. V.—*Contributions from the Sheffield Laboratory of Yale College.* No. XVI. *Contributions to Mineralogy;* by BEVERLY S. BURTON, Ph.B., Assistant in the Sheffield Laboratory.

I. *Enargite from Colorado.*

AMONG a series of ores received by Prof. Brush from Dr. Chas. Johnson of Colorado was a lustrous grayish black mineral, labelled "Sulph-antimonid of copper with arsenic," from Willis' Gulch, Colorado. It was found in a vein associated with iron pyrites and quartz. It has a perfect cleavage giving a brilliant metallic luster. Sp. gr.$=$4·43. H.$=$3. In the closed tube the mineral decrepitates and at a higher heat fuses, giving a sublimate of sulphur and sulphid of arsenic. In the open tube yields sulphurous acid and fumes of antimony with a crystalline sublimate of arsenous acid. B.B. on charcoal affords a strong odor of arsenic and a faint white coating of antimony. The roasted mineral treated with soda gives a globule of me-c copper. A qualitative analysis of the mineral showed the ence of sulphur, copper, antimony, arsenic and iron.

a the quantitative analysis the mineral was decomposed by chlorine method; about one gram of it was placed in the b of an ordinary reduction tube and treated in the usual mer with a slow stream of chlorine gas, the volatilized pro- t being made to pass through a mixture of chlorhydric and aric acids. The apparatus employed was the same as recom- ded by Rose with the exception that the U tube was replaced a tube filled with glass fragments saturated with the acid ture. The action of the chlorine was continued for nearly hour, when the bulb was detached and the chlorids of copper iron were dissolved in dilute chlorhydric acid, leaving a ll insoluble residue of undecomposed mineral. The cop- was thrown down from the hot solution by sulphydric acid, ler which circumstances it is easily washed without fear of dation; it was then dried and weighed as disulphid (Cu_2S). iron was determined in the filtrate as sesquioxyd and re- ed for the addition of the volatile portion. From the acid tion containing the volatilized chlorids the sulphur was own down as sulphate of baryta, and after removal of the ess of baryta salt, the arsenic was separated by the ammo- -magnesia solution. The antimony was precipitated from filtrate by sulphydric acid, the precipitate dried at 100° C., the antimony determined by heating a portion of it in a current of carbonic acid, and from this the total amount calculated. The small portion of iron in the filtrate from antimony was thrown down as sulphid, redissolved and verted into sesquioxyd and added to the portion previously ained. Two analyses conducted in this manner gave:

	I.	II.	Mean.
Sulphur,	31·46	31·67	31·56
Copper,	47·34	47·82	47·58
Arsenic,	17·67	17·93	17·80
Antimony,	1·25	1·50	1·37
Iron,	1·17	·91	1·04
	98·89	99·83	99·35

n No. 1, the insoluble residue was 2·16 pr. ct., in No. 2, 1·79 ct., which amounts have been deducted from the above results. e ratio of the equivalents of arsenic, copper and sulphur is 6 : 8, giving the formula $3Cu_2S+AsS_5$. This is the com- ition of Breithaupt's *Enargite* as determined from Platt- 's* analysis of the mineral from Peru, and also of the so- ed Guayacanite from Chili, analyzed and described by Field.†

Pogg. Ann., lxxx, 283.

† This Journal, II, xxvii, 252.

It is also in close accordance with Dr. Genth's[*] analysis of the enargite from Brewer's mine in South Carolina. The results demonstrate the mineral to be enargite, and this conclusion is fully sustained by its physical characters.

II. *Argentiferous Jamesonite.*

In the metallurgical collection of the Sheffield Scientific School is an interesting suite of ores from the Sheba Mine, Star City, Nevada, and among these Prof. Brush found an argentiferous sulph-antimonid of lead which he handed me for quantitative examination. The mineral is of a bluish white color, is massive to coarsely fibrous or columnar, and is associated with quartz, zinc-blende and tetrahedrite. H.=2·5. Sp. Gr.=6·03.

In the closed tube gives a sublimate of sulphur and sulphid of antimony. In the open tube affords sulphurous and antimonial fumes. B.B. on charcoal gives copious fumes of sulphur and antimony, with a coating of oxyds of antimony and lead, and yields a globule of lead, which on cupellation affords silver. A qualitative examination gave evidences of sulphur, antimony, lead, silver, copper and iron.

In the quantitative analysis the mineral was decomposed by chlorine as described under enargite. The contents of the bulb tube were removed and treated with dilute chlorhydric acid, brought upon a filter, washed with hot water, and the chlorid of lead thus dissolved was precipitated as sulphate. From the filtrate the copper was thrown down as sulphid by sulphydric acid gas. The residue containing the undecomposed mineral with chlorid of silver was washed upon the filter with ammonia to dissolve the latter, and the silver was subsequently separated as chlorid by acidulating the solution with nitric acid. As the first determination of sulphur proved low, an additional absorbent was attached to the end of the tube filled with glass fragments in the form of a nitrogen bulb apparatus, containing the mixture of chlorhydric and tartaric acids and a separate determination made; by this means the amount of sulphur was increased more than half a per cent. The antimony was determined as in the enargite. The results of two analyses were as follows:—

	I.	II.	Mean.			
Sulphur,	....	19·06	19·06	1·19		5
Antimony,	29·08	29·45	29·26	·24		1
Lead,	44·25	43·68	43·86	·424		
Silver,	6·15	6·13	6·14	·056	·50	2
Copper,	1·72	1·39	1·55	·024		
Iron,	·05	·05	·05			
		99·76	100·02			

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[*] This Journal, II, xxiii, p. 420.

No. 1, gave 1·34 pr. ct. insoluble residue, and No. 2, 1·72 pr. ct. which have been deducted from the above. The ratio of the combined equivalents of the lead, silver and copper to the antimony and sulphur is as 0·50 : 0·24 : 1·19 or very nearly 2 : 1 : 5, giving the formula $2(Pb, Ag, Cu)S+SbS_3$. This corresponds to the formula of Jamesonite, of which it seems to form an argentiferous variety. The content of silver may indicate its possible relation to Brogniardite, an antimonial sulphuret of lead and silver of like atomic proportions but containing a much larger amount of silver than the Nevada mineral. For the analyses the mineral was selected with great care, and it appeared perfectly homogeneous.

III. *Argentiferous Tetrahedrite.*

This mineral was one of a number presented to the metallurgical museum from the De Soto Mine, Star City, Nevada. It occurs in compact masses of a light gray color and is associated with quartz, zinc blende and pyrites. It is readily selected entirely free from impurities. Specific gravity 5·00. On examination it gave the pyrognostic characters of tetrahedrite, and the globule of copper obtained by reduction of the roasted assay gave on cupellation a comparatively large globule of silver.

For the analysis the same method of decomposition was employed as with the preceding minerals, with this modification: instead of using a bulb reduction tube, a straight tube was substituted in which the mineral was placed in a porcelain boat, and a nitrogen bulb tube was also added to the absorption apparatus as in the examination of Jamesonite. After the chlorine had been allowed to act a sufficient length of time, the boat was withdrawn and treated with dilute chlorhydric acid, and the chlorid of copper, thus separated from the insoluble chlorid of silver, was then precipitated with sulphydric acid and weighed as disulphid. The chlorid of silver was separated from the insoluble residue by solution in ammonia. It was found by use of the boat that a more perfect decomposition was effected than with the bulb reduction tube, and as it is much more convenient for the removal of the non-volatile chlorids, its use can be highly recommended to all who have occasion to employ this method of decomposing sulphids. In removing the chlorid of sulphur which condenses in the bend of the tube connected with the absorption apparatus, I have found that this does not readily absorb moisture from the air, even standing as directed for twenty-four hours, but this may be easily effected without generating heat by drawing a slow current of moist air through the apparatus by means of an aspirator. The sulphur and the antimony were determined as in the previous analyses. The iron and zinc in the filtrate from the antimony were thrown down by sulphid of ammonium, redissolved in chlorhydric acid, the iron precipitated by ammonia in excess, and the zinc subsequently separated by carbonate of soda. Two analyses gave :—

	I.	II.
Sulphur,	24·35	24.54
Antimony,	27·35	27·86
Copper,	27·40	27·42
Silver,	14·59	14·49
Zinc,	2·31	....
Iron,	4·27	....
Insoluble,	0·35	0·56
	100·62	

This corresponds closely with the argentiferous tetrahedrites analyzed by Rose and Klaproth from Wolfach.

These analyses were undertaken at the suggestion of Prof. Brush, and I would here express my thanks to him for his kind assistance in the above examinations.

ART. VI.—*On the occurrence of thick beds of Bituminous Gneiss and Mica Schist in the Nullaberg, parish of Ostmark, Province of Wermland, in Sweden;* by L. I. IGELSTRÖM.*

THE parish of Ostmark, as well as other parts of western and northern Wermland, is filled with high and steep hills of hyperite, between which the common crystalline rocks, gneiss, hornblende, mica schist and others, intervene. The bituminous gneiss and mica schist occur interstratified in common reddish granite-gneiss at the western part of the high and precipitous Nullaberg, occupying a thickness of more than 120 feet, and extending along almost the whole side of the mountain. The dip of the strata is about 70° eastward, and they are covered first by a bed of hyperite, and then with parallel strata of other granitoid rocks.

Generally, the bituminous substance is rather uniformly distributed, through the range, in the gneiss as well as in the mica schist, and the entire mass has a black color. The naked eye is hardly able to discern any particles of coal. When coarsely ground the rock resembles gunpowder, but when ground finer, it grows darker, either of the color of soot, or resembling pyrolusite. When beaten with the hammer, it emits a bituminous smell, like anthraconite, and also when heated by the blowpipe; it then gives a flame. On calcining 5·32 grams in an open crucible of platinum, I was not able completely to burn the whole of the bituminous substance, even after adding nitric acid several times; a little coal always remaining unconsumed. The loss of weight, however, was 12·03 per cent; the ashes were gray. When heated in a retort of thin iron, twelve pounds emitted much combustible gas, while a yellow combustible oil, as well as a colorless incombustible fluid, was collected in the receiver. When the gas was allowed to escape through a hole of one inch in diameter a fine and bright flame was obtained during four hours: during the fifth and sixth hour the flame grew more blue and fainter. The powder in the retort remained as black as before the distillation, though with a rather higher luster. It had lost 15·6 per cent of its volume. The specific gravity of the rock is 2·19.* It is so loose, that a man may in about half an hour sink in it a hole of two feet.

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* Translation received from the author. Published in Swedish in the Œfv. Ak. Stockholm, 1867.

On a closer examination of the bituminous strata it is very difficult, from the general homogeneousness of the bed to decide whether and where it is gneiss, or mica schist, that is, impregnated with bitumen, but nevertheless one finds that both the above-named rocks, and also thin layers of chlorite schist constitute parts of the range. Thus, above the main bed and somewhat separated from it, I met with thin layers of common mica schist, alternating with layers of mica schist more or less impregnated with bitumen. Silvery laminæ of mica also form thin seams in the main bed. With regard to the gneiss, on the other hand, one occasionally meets in the black bituminous rock with somewhat paler stripes and seams, showing that feldspar here forms the principal constituent of the mass. The stratification is, however, distinct enough to make evident that it is not a dyke, but stratified gneiss and mica schist, conformable to the surrounding parts, which is here in view. In some places the bituminous rock contains round, whitish, thinly interspersed particles of the size of a pea, as well as nodules of anthracite of about the same size. As I first supposed the latter to be asphalt, I concluded, that the whole bed was impregnated with that substance; when, however, these nodules afterwards were proved, by experiments, to be anthracite, that supposition lost its foundation and yet I cannot decide what kind of bituminous substance it is, that to so large an extent impregnates the rock. It seems nevertheless to be very obvious, that the impregnation is analogous to that in alum-slate, for instance, and that consequently our gneiss and mica schist must be removed from the place they occupy as "primitive rocks," to the series of sedimentary and fossiliferous strata, as limestone, alum-slate, &c.

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* When weighed in the hand, it feels very light compared with silicates in general.

[A section here omitted represents the hyperite, and reddish granitoid gneiss forming parallel beds with thin slaty layers of bituminous mica schist, and fine grained gneiss.]

Chemical analysis of the rock, by F. L. Ekman.

The following are the results of an analysis of various specimens of Nullaberg rock from the mineralogical collection of the Royal Academy of Science in Stockholm. * * * *

In five specimens of different character I found the following proportions of organic matter, (traces of water included) and carbonate of lime:

	1.	2.	3.	4.	5.
Organic matter,	7·10	10·67	10·36	5·44	9·08
Carbonate of lime,	2·57	(0·07)	14·30	2.75	0·00

The following is the analysis of the rock, when free from organic matter and carbonate of lime:

$\dddot{\mathrm{Si}}$ 65·03, $\dddot{\bar{\mathrm{Al}}}$ 19·61, $\dddot{\bar{\mathrm{Fe}}}$ 0·45, $\dot{\mathrm{Ca}}$ 0·19, $\dot{\mathrm{Mg}}$ 0·20, $\dot{\mathrm{K}}$ 14·46, $\dot{\mathrm{Na}}$ 1·06 = 100·00

When larger quantities (40 to 80 grams) were digested at the ordinary temperature with dilute nitric acid, well determinable quantities were obtained of phosphoric acid and chlorine, as also of lime, the last even in the specimen 5 (in which, though 11 grams were analyzed, no carbonic acid was found.) Hence one may conclude that the rock contains a little apatite. Traces of manganese and copper were also observed. The siliceous ingredients of the rock were also somewhat attacked, and as may perhaps be inferred, the traces of silica were separated before testing for phosphoric acid.

The organic ingredient may be easily obtained in a very pure state by washing, when a sufficient quantity of the rock is employed. The purest specimen that I obtained afforded after combustion only 3·17 p. c. of a reddish ash, but still contained some mineral fragments. The ash, of which such fragments constituted perhaps the principal part, showed no reaction on Curcuma-paper. In a few centigrams, collected after analysis, I found gypsum, oxyd of iron, silica (and phosphoric acid?) apparently derived from the combustion of the organic matter.

The carbonaceous substance thus purified forms a light powder of a beautiful bluish black color. It is but slightly hygroscopic and is not easily wetted with water. When heated, agglutinates a little, but without melting or sensibly changing its state of aggregation, and produces a transient but brilliant flame; the remaining coal smolders away very slowly. The specific gravity I found to be 1·299 ; after the removal of all remaining stony matter, it would probably be about 1·27. Analysis by combustion gave the following results : (ash and water being removed.)

The carbonaceous substance obtained from

	No. 3.	No. 2.		Medium.
Carbon, ...	88·68	88·79	—	88·74
Hydrogen, ...	5·35	5·56	—	5·46
Nitrogen, ...	—	—	0·67	0·67
Oxygen, ...	—	—	—	5·13
				100·00

The carbonaceous substance is generally but little affected by solvents. Spirit of 90 per cent pure alcohol became yellow and dissolved scarcely one per cent* of a substance, probably colorless when pure and easily soluble in alcohol ; when heated it yielded a thick white vapor and slowly blackened. Ether dissolved ½ per cent of a substance of the same nature but less colored. Chloroform, like alcohol, was colored deep yellow and left a similar residuum, the quantity of which was however not determined. Oil of turpentine had no more dissolving effect than alcohol or ether. The experiments with alcohol, ether and oil of turpentine, were performed by boiling the substance in the solvents for several hours.

A warm solution of 1 part of caustic potash in 6 parts of water dissolved 5 per cent and became black-brown. From this solution by the action of acids was obtained a very voluminous brown precipitate soluble in pure water. After the extraction of this 5 per cent, the remainder was unalterable in a heated solution of caustic potash, though exposed for several hours to its action.

The following are the results of some experiments made with reference to the products of dry distillation, performed on a small scale, the presence of air being as much as possible avoided, and in an apparatus that permitted a bright red-heat. When rapidly heated the substance* gave carbon 74 p. c. and volatile products 26 p. c. When slowly heated it gave 11 p. c. fluid products, of which about ¾ consisted of a yellow neutral oil, lighter the than water ; the gases developed were first acid, afterwards alkaline, and the water after distillation was strongly alkaline.

1 gram of the substance gave, rapidly heated, 258 c. c. of gas of 23° C., collected and measured over water. In the gas, when fully purified from carbonic acid, I found 2·7 vol. p. c. of hydrocarbons absorbable by bromine. In another experiment,

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* The substance always considered as free from ash.

where the oils were for the most part decomposed during the distillation, 313 c. c. of gas were obtained from 1 gram of the substance.

In the analysis of the organic substance, no attention was paid to the amount of sulphur contained. Even in the original rock, when melted with carbonate of soda, this element plainly shows itself, and in the carbonaceous substance, containing 3·17 p. c. ash, I found no less than 0·81 p. c. Whether the iron observed in the ash be there in sufficient quantity to unite with the sulphur and make pyrite, or whether, as is possible, there be an overplus of sulphur contained in the organic substance, is as yet undecided.

ART. VII.—*On a new Binocular Eye-piece for high powers;* by H. L. SMITH, Kenyon College.

WHILE experimenting with the apparatus for illumination of opake objects under high powers of the microscope, a description of which was subsequently published in this Journal,[*] the idea occurred to me that by using a small rectangular prism for the reflector of the illuminator, and a side tube that could be attached to it at pleasure, a binocular arrangement similar to that now made by Mr. Nachet could readily be adapted to any monocular instrument. I sent drawings to Mr. Wales for this purpose, some time before the publication already alluded to, requesting him also, to try for the reflector a plate of parallel glass, in such manner that the light reflected from one surface might pass up the side tube, and the light transmitted through the glass, up the main tube. Upon further thought, I devised the eye-piece now to be described, in order to more equally divide the light in the two tubes; and, feeling satisfied after roughly trying it, that it would be much superior to the plan I had suggested to Mr. Wales, I desired him to defer for a time the construction of the apparatus for which I had sent him the plans.

Having brought the illuminator to public notice, I tried again the effect of an eye-piece constructed mainly as described herein, with temporary tubes, and holding the apparatus in place simply while using it; although I did not notice any injurious reflection from the back surface of the glass plate, still, fearing this, I proposed to make it sufficiently wedge-shaped to throw the image from the posterior surface entirely out of the field, and to correct for the transmitted rays by making the wedge achromatic. I sent to Messrs. Powell & Leland a description of the eye-piece, requesting them to make it. Before receiving a reply from them, further experiment showed me that the most trifling amount of angle in a wedge of plain glass was sufficient to throw both reflected images together; when the refracting edge was placed upward, at the same time, the chromatic dispersion of the transmitted rays was imperceptible. Messrs. Powell & Leland replied: "You will no doubt be surprised to hear that we have patented a principle of binocular vision similar to what you propose. We exhibited it at the meeting of the Royal Society in March last." They also state that they got rid of the double reflection by other means than I had suggested, and seem doubtful whether my plan would work.

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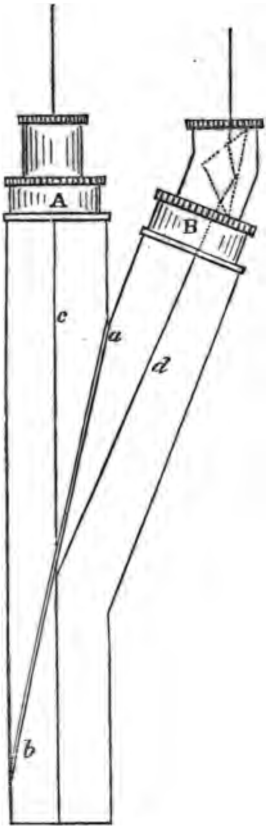
[*] Vol. xl, No. 119, Sept. 1865.

It apppears that the plan they had adopted was that which I had, more than six months previously, suggested to Mr. Wales, and which I had laid aside for the more perfect form. Evidently, the use of the Illuminator, as they constructed it, with a reflector of plate glass, first suggested the idea to them. Indeed, such an application could hardly have escaped the notice of those clever opticians. Shortly after, came a description of Mr. Wenham's improvement on Powell & Leland's arrangement, and which was said to afford a light nearly equal in each tube.

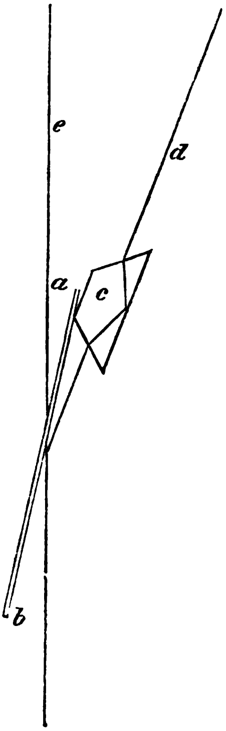
As this accomplished all I had been experimenting for, I gave the subject no further attention until after my return from England a few months since. I learned while there, that Mr. Wenham's contrivance was considered impracticable; it required a nicety of arrangement of the prisms which entirely unfitted it for ordinary use, however well it might operate in the hands of this most ingenious microscopist. I had several opportunities, both at Mr. Powell's house, and by the courtesy of Mr. Lobb, of witnessing the best performance of Powell & Leland's contrivance. It had certainly, a stereoscopic effect, and was, especially as manipulated by Mr. Lobb, much better than I had supposed it could be, still, the image in the extra tube was very faint.

Mr. Wenham, it is fair to say, alludes to the employment of a very thin wedge as a substitute for Powell & Leland's thick glass, in his paper published in the Microscopical Journal, July, 1866, and also, when alluding to the very small per cent of rays reflected in Messrs. Powell & Leland's arrangement, viz., 53·66 out of 1000, remarks: "To collect half the light the reflector would have to be set at 82½°, but this would cause the glass plate to extend to such a length, as to render the adaptation nearly impracticable." If Mr. Wenham had tried this he would have found that a glass plate two and a half inches long, would have answered every purpose and the construction in his hands would have been very easy. It will be at once perceived in the following description, that the images in the two fields are identical; or at least, so nearly so, that it is difficult to perceive any difference, and yet, most unexpectedly, there is a very considerable, and a very agreeable stereoscopic effect. Whatever theory may say, the fact is unquestionable. There is always a certain effect of depth or stereoscopic relief in using the monocular instrument, arising doubtless from the fact, that the parts not immediately in focus are somewhat blurred or doubled, and also from a sort of parallax, which causes a movement of the different parts of the image, readily seen as one looks alternately through the field by moving the head from side to side; the pulsation of the arteries causes movement. I have found sometimes this movement a great hindrance to steady vision of exceedingly delicate objects seen under very high powers. The fact of using both eyes, with two fields illuminated exactly alike, gives great physical relief, which imagination, if one chooses to call it so, gives very decidedly, a pleasing stereoscopic effect. The ingenious experiments of Mr. Claudet with the Thaumatrope, as described in the "Proceedings of the Royal Society," No. 92, (1867) show that the eyes are capable of appreciating a difference in the distance of two objects, which are only the $\frac{1}{1260}$ of the whole distance apart. Possibly, in the case of this binocular arrangement there may be a real, though infinitesimal difference in the two images. Certainly the rays do not all strike the glass at the same angle as they converge from the objective. It is not to be supposed, that, with very low power, the stereoscopic effect is as complete as that obtained by employing one-half of the objective for each tube, and perhaps therefore, this form may never wholly supercede the use of the "Wenham prism," yet it is so far satisfactory, even into the lowest powers, that one could hardly desire anything better, while with the higher powers, from the $\frac{1}{5}$th up to $\frac{1}{50}$th, it is infinitely superior. The eye-pieces I have made, and now have in use, have for the reflecting plate or wedge, simply slips of glass cut from photographic plate, and the ordinary thin glass used for cheap looking-glasses. It is quite easy, by holding the plate between the eye and the sash of a window, to select a proper piece at once. Of course a plate accurately ground would be far better; the sides of common plates of such glass as I have had, are generally more or less wavy. The thickness of the first described form is 1^{mm}, it is so slightly wedged-shaped that the difference in thickness of the two ends very carefully sured, I find to be only ·03^{mm}, and when placed about half eter from the eye, and three meters from the sash of a win- r, causes a displacement of the bar toward the refracting e, apparently less than one-third the thickness of the glass; h a glass plate, it will be seen, cannot produce any sensible omatic disturbance. This plate, cut and edges ground into oval shape, and 65^{mm}. in length, is placed at an angle of with the axis of the tube, the refracting edge, or thinnest t, toward the eye. Immediately at the top of the tube ich carries this plate, and which the plate crosses diagonally, laced the side tube for the reflected rays, while a continua- n of it receives the transmitted rays, the angle of inclina- n of the tubes is 20°; of course this angle will vary with angle of the wedge and must be found by trial. Fig. 1

1.



2.



presents in section this form; *a b* is the glass plate, *c* the ansmitted, and *d* the reflected ray. The cap of the eye-piece

B, contains a small prism, placed as represented, for redressing the reflected image; from this prism the reflected rays emerge, nearly parallel to the transmitted rays. The prism is small, and does not at all diminish the field of view; it has the effect of lengthening the path of the reflected rays so that although the eye-piece B is at a lower level than A, yet the tops of the caps of the eye-pieces are in the same plane and the union is easy with both eye-pieces. In this form, some means must be adopted of retaining the prism both with its reflecting face always parallel to the face of the plate *a b* when the eye-pieces are drawn out to vary the distance. The second form will probably be preferred; when the microscope is to be constructed as a permanent binocular, it is represented in fig. 2, *a b* is the glass plate, at the top of this plate a truncated rectangular prism *c*, is placed with its reflecting face parallel, but slightly inclined, to the face of the plate *a b*; the proper position is determined by experiment. It is so arranged that the images are the same in both fields; *d*, is the twice reflected, and *e* the transmitted ray. The eye-piece is placed *above* the prism in this case, and the prism is made sufficiently large to allow the use of the whole field; the eye-piece may be placed directly in contact with the prism if it is sufficiently large.

In both these forms, and they work equally well, the adjustment for different width of eyes, may be made by sliding out or in the two eye-pieces. It is quite true that when the images, reflected from the front and back of a thin plate of glass, are united by giving a slight inclination to these faces, i. e. making the plate very slightly wedge-shaped, that this union of images is only at a definite distance from the objective, and drawing out the eye-piece, should therefore give a slight overlapping of the images. Now this really does occur, but to so slight an extent as to be practically of no detriment. Indeed, it is entirely unpercieved with all classes of objects except one; when a number of very opake objects, e. g., thick scales from the wing of a butterfly lying close together, and upon each other, are shown upon a very bright field, the double reflection can be detected if the eye-piece is drawn out, or put in; beyond a certain point it vanishes entirely when the eye-piece is at the proper distance. I cannot, however, with the very highest powers on the diatomacea, or with lower powers on parts of insects, or the transparent injections, see any trace of it in the eye-pieces I have made, with all necessary change of eye-pieces to suit the ordinary varying distance of the eyes. It is obvious, that in the construction, fig. 2, the distance between the eyes may be allowed for, without sliding out the eye-piece by changing the inclination of the two tubes and rotating the prism *c* on its axis, in this case, since the reflected ray *d* will travel over twice the angle which the prism is moved; some means, similar to that devised by Nachet, must be adopted for causing the prism, whenever the inclination of the two tubes are varied to suit different eyes, to move over just half the angle described by the movable tube. By this arrangement, the union of the two images from the two surfaces of the glass plate, will be quite undisturbed. It will be apparent that the glass slip *a b* may be turned aside, so as not to interfere with the use of the instrument as a monocular. I think, however, no one who has enjoyed the luxury of binocular vision, so complete as this is, will be disposed to return to the old form, for even with the common glass I have used, I can percieve no detriment to the definition, and but a trifling loss of light.

ART. VIII.—*On Wilsonite from St. Lawrence County, N. Y.;*
by E. W. ROOT.

UNDER the name of Wilsonite, Dr. Sterry Hunt has described, in the Geological Survey of Canada, 1863, a mineral from Bathurst, C. W., which is principally a hydrated silicate of alumina and potassa. A short time since I found in the cabinet of Prof. Root of Hamilton College, several specimens of a mineral from St. Lawrence county, N. Y., resembling in appearance the pink scapolite from Bolton, Mass., but easily distinguished therefrom, by a much inferior grade of hardness. This mineral in its physical properties, action before the blowpipe, and behavior with acids, resembles precisely the wilsonite of Hunt. It occurs in peach-blossom red, prismatic masses, possessing two parallel cleavages at right angles to one another. Its hardness is about 3·5. Its specific gravity 2·77–2·78. Its luster is vitreous, and in thin fragments it is translucent. Before the blowpipe it fuses readily with intumescence to a white enamel. Concentrated acids decompose it, the silica separating in a pulverulent from. A qualitative analysis gave the same components as those of the Canada mineral, silica, alumina, lime, magnesia, potassa, soda, and water, with a trace of manganese. It also contained, quite intimately associated with it, some 15 per cent of carbonate of lime.

After removing the carbonate of lime with dilute hydrochloric acid, the mineral gave as the result of a quantitative analysis—

SiO_2	Al_2O_3	MgO	CaO	KO	NaO	HO
47·46	30·51	3·63	0·53	8·78	2·43	6·09 = 99·43

These numbers agree quite closely with those of the following analysis of the Canada wilsonite by Dr. Hunt.

SiO_3	Al_2O_3	MgO	CaO	KO	NaO	HO	
47·70	31·22	4·14	0·39	9·38	0·95	5·35	= 99·13

The mineral analyzed by me was found several years since by Prof. Root near Oxbow on the road to the Rossie lead mines in St. Lawrence county. It occurs in connection with calcite, green hornblende (pargasite), and steatite (rensselaerite of Emmons,) while throughout the whole mass of the mineral small scales of graphite are disseminated.

There can be no doubt but the wilsonite of Hunt and this mineral are identical.

Wilsonite possesses a composition very similar to gieseckite, parophite, dysyntribite and agalmatolite. It is supposed by some eminent mineralogists to be an altered scapolite, while others consider it to have always possessed its present composition, and not to be the result of a metamorphic action.

School of Mines, Columb. Coll., N. Y., Nov. 11, 1867.

ART. IX.—*On the action of hydrated hypochlorous acid on Oil of Turpentine and Camphor;* by C. GILBERT WHEELER.

OIL of turpentine and camphor are chemically closely related, differing in composition by only a single molecule of oxygen.

$C_{10}H_{16}$	$C_{10}H_{16}O$*
Oil of turpentine.	Camphor.

The intimate relation here indicated, has been by Berthelot clearly proven to exist, he having obtained camphor from oil of turpentine by combining the latter with hydrochloric acid, separating it therefrom as camphene—isomeric with oil of turpentine—and oxydizing platinum sponge.† Camphor may thus be considered as "Oxy-camphene." Dussart has recently claimed to have succeeded in obtaining camphor direct from oil of turpentine.‡

With regard to the relation of bodies to the homologous series of the fatty and aromatic acids it may be observed that where the number of molecules of carbon are the same, the members of the fatty series contain more hydrogen while those of the aromatic series contain less. Oil of turpentine, therefore, with its numerous isomerically allied bodies (terbenes), occupies a position intermediate between these two important groups of organic bodies, as the following example will illustrate:

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* C=12. O=16.

† Jahresbericht, 1858, p. 441.

‡ Zeitschrift für Chemie, 1867, 11.

$C_{10}H_{20}$	$C_{10}H_{16}$	$C_{10}H_{14}$
Diamylene.	Oil of turpentine.	Cymol.

That on the one side, oil of turpentine sustains the intimate relation to the aromatic series here assumed, has been by experiment abundantly illustrated. I need only to refer to the formation of terephtalic acid and nitrobenzol from oil of turpentine and the formation of cymol from camphor. The relations, however, to the fatty series of the bodies under consideration have not been thus satisfactorily demonstrated. Now oil of turpentine occupies apparently a similar position with reference to capric acid as acetylene does to acetic acid, as is herewith shown:

$C_{10}H_{16}$ Oil of turpentine.	$C_{10}H_{20}O_2$ Capric acid.
C_2H_2 Acetylene.	$C_2H_4O_2$ Acetic acid.

It appeared to me, therefore, to be a subject worthy of investigation to ascertain whether the relations above expressed could be proven by experimental research. I have for this purpose, made use of hydrated hypochlorous acid as a reagent, and have been able to obtain a substance which may be regarded as belonging to the series of the fatty acids.

If oil of turpentine (boiling point 159°) is added to a dilute aqueous solution of hypochlorous acid and shaken, it at once becomes yellow, thick and heavy, and soon settles to the bottom of the vessel. Were concentrated acid employed, the mixture would rapidly become heated and other products be formed than that sought, or, under the most favorable circumstances, but very little of the new body would be obtained. The oil should be slowly added, not allowing an increase of temperature, and ceasing when on adding a fresh portion, but slight change in color is produced, or before the characteristic odor of the hypochlorous acid can no longer be readily recognized.

The heavy oil is separated from the aqueous solution by filtration. The latter contains chlorid of mercury, originating from the oxyd of that metal employed in the preparation of the hypochlorous acid, also an organic substance, which, on evaporating the solution, separated as an oil with more or less decomposition. This is the most interesting of the products of the reaction, and in order to obtain it pure from the solution it is necessary to avoid the application of a high temperature.

To effect this, a quantity of common salt is added till the solution is saturated, which is then shaken with small portions of ether. The etherial extracts are united and shaken with a concentrated solution of chlorid of ammonium, which takes up all the mercury chlorid, the ether is then removed with a pipette and chlorid of calcium added in order to effect its dessication. The filtrate is distilled and at the close of the operation a current of dried air is transmitted through the residue in order to more completely remove all traces of ether. The body thus obtained is the product of the direct combination of hydrated hypochlorous acid with oil of turpentine, and on its combustion I obtained the following results:

0·3450 gm. yielded 0·6190 gm. carbonic acid and 0·2340 gm. water.
0·2985 " " on ignition with lime, 0·3270 " AgCl.

These figures indicate the formula $C_{10}H_{18}Cl_2O_2$.

		Theory.	Found.
C_{10}	120	49·79	48·93
H_{18}	18	7·46	7·53
Cl_2	71	29·46	29·00
O	32	13·29	

This substance is therefore formed according to the following equation:

$$C_{10}H_{16}+2\left(\left.\begin{matrix}Cl\\H\end{matrix}\right\}O\right)=C_{10}\left.\begin{matrix}H_{16}\\H_2\end{matrix}\right\}\begin{matrix}Cl_2\\O_2\end{matrix},$$

and judging from its empirical formula, might be viewed as bichlorinated capric acid; it, however, is entirely without the chemical characteristics that would appertain to such a body. We have rather here before us, the dichlorhydrin of a four-atomic alcohol, and which must beyond doubt be considered as belonging to the fatty acid series. Between this substance and that obtained by Neuhoff* from naphtalin there is the most complete analogy, as the following comparison illustrates:

$C_{10}H_{16}$ Oil of turpentine, (Terebentene).	$C_{10}H_{18}Cl_2O_2$ Dichlorhydrin of Terpen-alcohol.	$C_{10}H_{20}O_4$ New 4-atomic alcohol, (Turpen-alcohol).
$C_{10}H_8$ Naphtalin.	$C_{10}H_{10}Cl_2O_2$ Dichlorhydrin of Naphten-alcohol.	$C_{10}H_{12}O_4$ Naphtalin-alcohol, (4-atomic).

Dichlorhydrin of terpen-alcohol is a colorless, transparent, viscid substance, of a somewhat greater consistence than turpentine, completely neutral, difficultly soluble in water, but readily soluble in ether and alcohol. On heating its alcoholic solution with nitrate of silver, chlorid of silver is formed. It cannot be distilled, for before the necessary temperature is attained, decomposition commences and hydrochloric acid is given off. With nitric acid it is oxydized and yields a resinous mass.

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* Zeitschrift für Chemie, 1866.

The above mentioned, as yet unknown, terpen-alcohol I attempted to obtain by treating the dichlorhydrin with baryta; however, there appeared to result a too energetic decomposition of the substance. I further tried the action of zinc and sulphuric acid, hoping to substitute hydrogen for the chlorine of the substance, was however, unsuccessful. I was, nevertheless, able to obtain with sodium a derivative of this dichlorhydrin. If sodium is added to the etherial solution, there is formed, after some hours, much chlorid of sodium and a yellow substance settles to the bottom of the vessel. If the whole is then treated with ether and the latter evaporated, there remains a thick mass which still gives a chlorine reaction. However, on digesting that portion not taken up by the ether with alcohol, filtering the same from the insoluble chlorid of sodium, the concentrated filtrate when slightly acidulated with sulphuric acid and shaken with ether, yields, on evaporating the etherial solution, a body containing no chlorine. This is insoluble in water, but soluble in alcohol and ether. It yielded no crystalline compounds with metalic bases, and its ammonia salt decomposed on evaporation. The lead, silver and copper salts, were amorphous powders, and the isolated acid could not be obtained crystallized, but only as a brownish translucent solid. On combustion I obtained from 0·1360 grm., 0·328 grm. carbonic acid and 0·1070 grm. water, which would indicate the formula $C_{10}H_{16}O_3$.

		Theory.		Found.
C_{10}	120	65·21	- - -	65·75
H_{16}	16	8·69	- - - -	8·75

The formation of this acid can hardly be imagined to be the result of any very simple reaction; doubtless the dichlorhydrin, on parting with its chlorine, splits up into secondary products. As the quantity obtained of this body was but small, I was unable to study its chemical relations more completely. In view, however, of what shortly follows, and referring to the same, I would propose "Hydrophoronylic acid" or "Oxy-camphinic acid" as a suitable name for this substance.

Dichlorhydrin of terpen-alcohol is, however, only obtained in small quantities when oil of turpentine and hypochlorous acid are brought into contact. The chief product is the heavy oil first alluded to. A quantity of this was dissolved in alcohol, precipitated with water, redissolved in ether, dessicated, distilled, and thus obtained pure. The results on analysis were the following:

0·270 gm. gave 0·532 CO_2 and 0·177 H_2O=53·74 carbon and 7·28 hydrogen.
0·407 " " 0·800 " 0·255 " =53·61 " 6·92 "
0·340 " " 0·529 AgCl=38·36 chlorine.

These figures lead to no simple or at all probable formula; the body was possibly a mixture of mono- and trichlorinated oil of turpentine. A mixture of equal equivalents would demand 53·99 p.c. carbon, 6·08 hydrogen and 39·93 chlorine. This oil decomposed with evolution of hydrochloric acid on heating. It is also decomposed with formation of chlorid of potassium on digesting with an alcoholic solution of potassa. If it is heated for some time with nitric acid a small quantity of a volatile substance very irritating to the eyes is formed, together with a very considerable quantity of a resinous mixture from which was extracted with warm water, oxalic acid and another acid which slowly crystallized from the solution on standing. The crystals were readily soluble in ether and alcohol, and on ignition gave forth the odor of acetic acid. Dissolved in water and acetate of lead added, a salt was precipitated, which, on analysis, yielded 66·34 p. c. lead, 0·2805 gm. of substance giving 0·2725 sulphate of lead. Malonate of lead requires 66·99 p. c. of lead. From these various data, it became evident that the heavy oily substance formed from the oil of turpentine is a mixture, only that remaining in solution in the water present, being a simple body.

As we have seen that two molecules of hydrated hypochlorous acid unite direct to oil of turpentine, it appeared to me interesting in this connection to investigate whether chloric acid is capable of being similarly added, as Carius has succeeded in doing with benzol, obtaining the acid named by him trichlorphenomalic acid.* Carius employed a mixture of chlorate of potassa and sulphuric acid and proved that in the presence of benzol, the chloric acid is reduced to chlorous acid and the latter unites with the benzol direct. An analogous reaction appears to take place where oil of turpentine is employed. I obtained with turpentine a finely crystallized body which is perhaps the substance sought, having the formula $C_{10}H_{18}C_2O_4$. I hope to give this reaction a closer investigation.

At the outset, I referred to the intimate chemical relation existing between oil of turpentine and camphor, and with this in mind it may be interesting to investigate also the action of hypochlorous acid on camphor, a substance partaking on the one hand much of the nature of an aldehyd, and on the other, that of an alcohol. Its behavior on being treated with a solution of potassa in alcohol, splitting up into an alcohol (borneol) and an acid, resembles that of an aldehyd.† It does not, however, unite with bisulphites of the alkalies and it admits of having a molecule of hydrogen substituted for one of potassium or sodium, as is the case with the alcohols.* The true chemical structure of camphor must be determined by a further study of its derivatives.

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* Annalen der Chem. und Pharm., 1867.

† Berthelot, Annalen Chem. und Pharm., ci, 94.

While a dilute solution of hypochlorous acid acts readily and rapidly on oil of turpentine, its action on camphor is exceedingly slow. In the first experiment I allowed camphor to remain in a weak solution of hyponitrous acid for eight days, and thereupon one day in a concentrated solution. The product of the reaction, a white, indistinctly crystallized solid, was washed with water till no acid reaction remained, dissolved in alcohol and again precipitated by diluting with water. It still contained a small quantity of an oily substance, held mechanically, and which was removed by strongly pressing between filter paper. It was again crystallized and then was submitted to an analysis.

0·3255 grm. gave 0·6035 grm. carbonic acid and 0·178 grm. water.
0·4995 " " 0·611 " AgCl
0·260 " " 0·382 " "

From these figures the formula $C_2H_{27}Cl_5O_3$ may by calculated.

		Theory.	Found. I.	II.
C_{20}	240	50·37	50·57	
H_{27}	27	5·66	6·07	
C_5	177·5	37·27	37·63	37·11

The formation of this substance can be explained by the following equation:

$$2(C_{10}H_{16}O)+5ClHO=C_{20}H_{27}Cl_5O_2+5H_2O.$$

The result is a different and a much simpler one where camphor is immediately brought in contact with concentrated hypochlorous acid; it is at once transformed into a thick fluid, becomes warm, and after some time again hardens to a crystalline solid. This body is the chief product of the reaction, though a very small quantity of another organic substance is found in the solution. The crystalline substance is dissolved in alcohol, precipitated with water and thoroughly washed with cold water. It is then again repeatedly dissolved in alcohol and crystallized therefrom until obtained quite pure. On its analysis I obtained the following results:

0·2320 grm. gave 0·5940 grm. carbonic acid and 0·1710 grm. water.
0·2295 " " 0·1615 " chlorid of silver.

These figures correspond with those of simple chlorinated camphor.

		Calculated.	Found.
C_{10}	120	64·35	64·54
H_{15}	15	8·07	8·18
Cl	35·5	19·03	18·70

* Baubigny, Zeitschrift für Chemie, 1866, p. 408.

The following equation expresses the reaction:

$$\underset{\text{Camphor}}{C_{10}H_{16}O}+ClHO=\underset{\text{Mono-chlorinated camphor.}}{C_{10}H_{15}ClO}+H_2O.$$

Substitution products of this character appear in general to be the chief results of the action of the reagent here employed; addition products are formed only in small quantities. Carius obtained from benzol, monochlorinated benzol, together with a body named by him "trichlorhydrin der Phenose."* Monochlorinated camphor has not heretofore been obtained, though Clauss has obtained products containing four and six atoms of chlorine by the action of chlorine on camphor dissolved in trichlorids of phosphorus.†

Monochlorinated camphor is a white crystalline powder, soluble in ether and alcohol, insoluble in water. Its solution in concentrated alcohol on evaporation remains for a long time of a syrupy consistence; from dilute alcohol it crystallizes more readily and in very small, imperfectly formed needles. It melts at 95° C., is decomposed, with liberation of hydrochloric acid, at 200° C., and another substance, having an agreeable odor, is sublimed over. The taste and smell of this body are similar to ordinary camphor. It is acted on with difficulty by nitric acid even when boiling; by sulphuric acid it is dissolved at ordinary temperatures and again precipitated on dilution with water. With nitrate of silver its alcoholic solution yields chlorid of silver. Heated to 120° with concentrated solution of ammonia, chlorid of ammonium is formed and a derivate soluble in water. Treated with perchlorid of phosphorus there remained, after the removal of the oxychlorid of phosphorus formed, a substance which blackened on attempting to distill a portion. Its distillation was therefore not proceeded with, but it was washed with water, dissolved in alcohol and again precipitated by dilution. The oil-like substance thus obtained soon became a magma which yielded white crystals on pressing between filter paper. The substance was probably either the body $C_{10}H_{15}Cl_3$, or that resulting therefrom on subtracting one atom of hydrochloric acid, viz: $C_{10}H_{14}Cl_2$.

A considerable quantity of monochlorinate of camphor was treated with a solution of potassa in alcohol for 6 to 8 hours. The whole thereby became brownish-red and a large quantity of chlorid of potassium was formed. On dilution with twice its volume of water a voluminous precipitate (A) was obtained. The filtrate gave no precipitate on farther addition of water, and contained the potassa salt of a new organic acid. The latter was isolated on addition of sulphuric acid, then dissolved in ether, filtered, and thoroughly dried after evaporation of the ether. Its analysis yielded the following results:

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* Zeitschrift für Chemie, 1866, p. 67.

† Annal. Chem. und Pharm, cxxxvi, 323; xliv, 301.

0·2608 grm. gave 0·6318 grm. carbonic acid.*
0·2496 " " 0·6040 " " and 0·1870 grm. water.

These figures correspond with the formula $C_{10}H_{14}O_3$.

	Calculated.		Found. I.	Found. II.
C_{10}	120	65·93	66·07	65·99
H_{14}	14	7·70		8·23

The acid was neutralized with ammonia and acetate of lead added. 0·2240 grm. of the lead compound gave 0·1180 grm. sulphate of lead = 36·21 pr. ct. lead. The formula $C_{10}H_{13}PbO_3$, requires 36·42 p. c. The acid is therefore monobasic and has the following rational formula: $(C_9H_{13}O)\,CO\,.\,OH$. The radical requires one molecule of hydrogen in order to become phoron, and an experiment with a small quantity, by heating with lime, made it apparent that this substance was produced as it is in like manner from some other camphor derivatives. I therefore name this body phoronylic acid. Phoronylic acid is isomeric with camphoric acid; it is a syrupy fluid, not soluble in water, readily soluble in ether and alcohol. It has but slight odor, somewhat resembling cumarin. This odor is especially marked when the substance is heated with sulphuric acid and chromate of potassa. The alkaline salts of phoronylic acid are readily soluble in water and appear not to crystallize; the ammonia salt loses its ammonia on evaporation. The salts of the heavy metals are insoluble.

The precipitate (A), mentioned in the foregoing, dissolved in alcohol, yielded on evaporation beautiful crystalline needles. Obtained pure by repeated crystallization and analyzed, the following were the results:

0·1970 grm. gave 0·5130 grm. CO_2 and 0·1659 grm. H_2O, which indicate the substance $C_{10}H_{16}O_2$.

		Calculated.	Found.
C_{10}	120	71·43	71·02
H_{16}	16	9·52	9·36
O_2	32	19·05	....
		100·00	

The reaction may be thus expressed:

$$\underbrace{C_{10}H_{15}ClO}_{\text{Monochlorinated Camphor.}} + KO\,H = \underbrace{C_{10}H_{16}O_2}_{\text{Oxycamphor.}} + KCl$$

Oxycamphor crystallizes in small white needles, is easily soluble in alcohol, insoluble in water, melts at 137°, may be sublimed without change, volatilizes somewhat even in boiling water and resembles ordinary camphor in taste and odor. Oxycamphor is isomeric with camphinic acid dicovered by Berthelot. According to that chemist, ordinary camphor on being heated with an alcoholic solution of potassa splits up into borneol and an acid which he presumed to have the composition $C_{16}H_{16}O_2$.[*] He did not analyze the acid but explained the process of its formation as follows:

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* The hydrogen determination met with an accident.

$$\underbrace{2(C_{10}H_{16}O)}_{\text{Camphor.}} + KOH = \underbrace{C_{10}H_{18}O}_{\text{Borneol.}} + \underbrace{C_{10}H_{15}KO_2}_{\text{Camphinate of potassa.}}$$

It appeared to me desirable to analyze this substance and establish its isomeric character with oxycamphor. A quantity of camphor was therefore heated with an alcoholic potassa solution in a sealed tube to 180° for 6 to 8 hours. On opening the tube an inflammable gas escaped. (Probable H and CH_4 from decomposed alcohol.) The contents of the tube were diluted with water, the precipitated borneol and camphor filtered off and the filtrate completely neutralized with sulphuric acid. On concentrating till all the potassic sulphate had crystallized out, the mother-liquor was acidified with sulphuric acid, the precipitated camphinic acid washed with water, dissolved in ether and obtained therefrom by evaporation. The acid thus obtained corresponded completely with that described by Berthelot. It was an almost solid, "fast feste," transparent mass which, on account of its peculiar consistency, was very difficult to entirely free from moisture, and this doubtless accounts for the carbon determination in the subjoined analysis being too low. Nevertheless, there remains no doubt that the formula assigned to it is correct and that it is isomeric with oxycamphor.

The results of analysis were: 0·236 grm. substance, 0·610 grm. carbonic acid, and 0·211 grm. water.

		Calculated.	Found.
C_{10}	120	71·43	70·56
H_{16}	16	9·52	9·91
O_2	32	19·05	....

Camphinate of lead, dried at 100°, a white insoluble powder, yielded the following results on analysis:

0·1390 grm. substance gave 0·0787 grm. sulphate of lead = 38·77 p. c. lead. The theory calls for 38·26 p. c.

Camphinic acid is perhaps capable of yielding capric acid, or some body isomeric therewith, on submitting it to the action of nascent hydrogen.

A summary view of the established results of the foregoing investigation and their closer allied chemical relations may be gathered from the following statement of formulæ.

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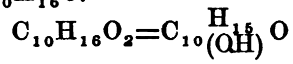
[*] Ann. der Chem. und Pharm., cxii, 364.

Oil of turpentine=Camphene, $C_{10}H_{16}$.
Camphor =Oxycamphene, $C_{10}H_{16}O$.
Oxycamphor =Dioxycamphene, 
$C_{10}H_{16}O_2=C_{10}\begin{matrix}H_{15}\\(OH)\end{matrix}O$

Camphinic acid,	$C_{10}H_{16}O_2=(C_9H_{15})CO.OH$
Oxycamphinic acid (hydrophornylic acid),	$C_{10}H_{16}O_3=(C_9H_{15}O)CO.OH$
Phoronylic acid,	$C_{10}H_{14}O_3=(C_9H_{13}O)CO.OH$
Monochlorinated camphor,	$C_{10}H_{15}ClO$
Terpendichlorhydrine,	$C_{10}H_{18}Cl_2O_2$

In closing, I acknowledge with pleasure the valuable service in connection with the foregoing, of my assistant, Mr. Oscar Loew.

Nuremberg, June, 1867.

ART. X.—*On the Oxydation of Diamylene with Chromic Acid;* by J. WALZ, Ph.D.

AT the instigation of Prof. Erlenmeyer (in Heidelberg), who proposes to ascertain the relative constitution of Diamylene, I undertook the oxydation of this substance with chromic acid.

I used amylene which boiled between 35° and 40° C. This was polymerized rapidly and completely according to the method described by Erlenmeyer[*] and almost the whole of the product thus obtained, distilled at 153°–170° C. In order to test its purity it was treated with bromine in a narrow tube which was surrounded by cold water; the bromine was added gradually, every drop added causing a hissing sound and a considerable evolution of hydrobromic acid.[†] When the liquid had assumed a reddish-brown color it was purified, washed and dried according to the usual methods. The product thus obtained was not Bauer's bibromid ($C_{10}H_{20}Br_2$),[‡] but the *monobromid of diamylene bibromid,* $C_{10}H_{19}Br_3$. It is an almost colorless oil, heavier than water and has a weak, but not disagreeable odor of camphor. It decomposes and turns brown at 100° C. It was analyzed with the following results:

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[*] Verhandlungen des naturhistorisch medicin. Vereins, Heidelberg, vol. iii, 1865–6.

[†] Although the temperature of the liquid during the operation was about 15° C., no carbonization could be observed. Compare: Bauer, Sitzgsberichte der Wiener Akademie, xliii, 96.

[‡] C=12, O=16, S=32, &c.

I. 0·2235 grms. of the substance furnished 0·2541 CO_2 and 0·1063 H_2O.

II. 0·2093 grms. furnished 0·2472 CO_2 and 0·1007 H_2O.

	$C_{10}H_{19}Br_3$ demands:	Found. I.	II.
C,	31·66	31·00	32·20
H,	5·01	5·28	5·34
Br,	63·33		
	100·00		

The oxydation.—At one time 14 grms. of diamylene were mixed with 100 grms. of bichromate of potassa, 150 of sulphuric acid (spec. gravity=0·1842) and 150 of water; in a second experiment 32 grms. of diamylene, 228 of the bichromate and 442 of sulphuric acid and of water, each, were employed, these quantities being required to supply 10 atoms of oxygen. This mixture was put into a spacious glass-balloon, which was connected with a reversed "Liebig's cooler" and was shaken until the substances began to act upon each other. The reaction soon became very intense, the liquid fairly boiling, and large quantities of carbonic acid being evolved. When the reaction had somewhat subsided, the oxydation was completed with the aid of a lamp; but in neither case was all the chromic acid reduced. The contents of the balloon were then diluted with water and distilled, furnishing a green oil and a few drops of an oily acid; the water which distilled over contained also a great deal of acid. A greenish resinous mass remained behind in the balloon, floating on the surface of the liquid.

The green oil.—Immediately after distillation this oil seems to hold some acid in solution; it was, therefore, neutralized with soda, washed with water and dried over chlorid of lime. In this way about 12 c.c. m. of the oil were obtained from 32 grms. of diamylene. It has no fixed boiling point, the thermometer rising from about 128° to 200° C. during its distillation. The following are the results of various analyses:

I. 0·1006 grms., taken from the entire quantity of the oil after drying with chlorid of calcium, yielded 0·2643 grms. CO_2 and 0·1206 H_2O.

II. 0·0996 grms., boiling at 140°–160° C., yielded 0·2690 CO_2 and 0·1236 H_2O.

III. 0·1646 grms., boiling at 160°–180° C., furnished 0·4552 grms. CO_2 and 0·1974 H_2O.

IV. 0·2016 grms. boiling at 180°–200° C., furnished 0·5667 CO_2. The determination of the water was lost.

	I.	II.	III.	IV.
C,	70·39	72·75	75·41	75·54
H,	13·30	13·75	13·32	....

			C.	H.
The formula	$C_7H_{14}O$	requires	73·68	12·28
" "	$C_8H_{16}O$	"	75·00	12·50
" "	$C_9H_{18}O$	"	76·05	12·67
" "	$C_{10}H_{20}O$	"	76·92	12·82

It would, consequently, appear most likely to consider this oil as a mixture of these various oxyds and as perhaps still containing diamylene which had not been attacked during the process of oxydation. It possesses a yellowish-green color, a penetrating odor of camphor and of mint; its specific gravity is less than that of water; it does not combine with bisulphite of soda and it is in no way affected by a temperature of 20° C. It appears to be difficult to dry it completely with chlorid of calcium, and sodium cannot be employed because it affects the oil chemically.

Hoping to obtain some farther information concerning the constitution of this substance, or, at least, to purify it by oxydizing the diamylene which it possibly still contained, I treated 6 grms. of the oil with 5 grms. of bichromate of potash, 8 grms. of concentrated sulphuric acid and 16 of water in a glass balloon connected with a reversed 'Liebig's cooler.' The course of this oxydation resembled exactly that of diamylene itself; the formation of acids, both oily and soluble in water, and of a resinous substance took place, while about 4 grms. of the oil, which still possessing the characteristic smell and color, now showed the following composition:

I. 0·0907 grms. of the substance yielded 0·2536 CO_2 and 0·1104 H_2O.

II. 0·1098 grms. of the substance yielded 0·3046 CO_2 and 0·1435 H_2O.

	I.	II.
C,	81·69	81·53
H,	13·52	13·53

This composition answers very nearly to the formula $C_{20}H_{40}O$ (which would be the oxyd of tetramylene) which requires 81·08 p.c. C, 13·51 H, and 5·41 O. Still it would seem as if merely a farther oxydation of the products intermediate between the diamylene and the acids described further on, had taken place in this instance, and, consequently, no definite formula can as yet be assigned to this oil.

The acid distillate.—The acid distillate, mentioned above, was neutralized with soda and evaporated to dryness. A considerable quantity of a salt, part of which proved to be deliquescent, was obtained in this way. It was decomposed with sulphuric acid and distilled, furnishing an oily acid and water of a strongly acid reaction. The oily acid was separated and collected by itself and found to be a colorless syrup which shows no sign of crystallization at a temperature of 20° C. It was exactly neutralized with ammonia and precipitated with nitrate of silver. The precipitate formed a white, cheesy, voluminous mass, which is almost insoluble in water. Two analyses showed that the dry salt contained 40·66 and 40·88 p. c. of silver.

I. 0·1773 of the salt yielded 0·0721=40·66 p. c. Ag.
II. 0·1634 " " " 0·0668=40·88 " "

This composition would correspond to several salts, and we prefer, therefore, to leave the final decision to further investigations.

The water which distilled with the foregoing acid had a sour reaction and the smell pointed to the presence of acetic acid. It was several times partially neutralized with nitrate of silver, and the salts which crystallized out, were analyzed:

I. 0·1589 grms. of the dry salt left 0·1021=64·25 p. c. Ag.
II. 0·1698 " " " " 0·1086=63·95 " "
III. 0·1232 " " " " 0·0794=64·44 " "
IV. 0·2328 " " " " 0·1505=64·65 " "

Acetate of silver requires 64·67 p. c. Ag.

The salt analyzed under IV had been obtained as follows: the liquid was left in contact with the oily acid for several days, and shaken with it from time to time in order to dissolve as much of it as possible; it was then separated and subjected to a fractional distillation, which was suspended as soon as oily acid ceased to distil. The liquid which remained behind in the retort was neutralized with nitrate of silver while it was still hot, and on cooling down, a beautiful crystallization of acetate of silver was obtained. The purity of the salt, as disclosed by analysis, proves the absence of any acid intermediate between acetic acid and the one before described. I must mention yet that the amount of acetic acid formed is very large.

The tarry substance.—The tarry substance which I have mentioned above as having remained behind in the balloon after the distillation of the other products of oxydation, was boiled with dilute sulphuric acid and alcohol, the solution poured off and the chromium precipitated with soda. The solution was decanted from the precipitate* and evaporated to dryness on the water-bath. A deliquescent salt remained behind which was decomposed with sulphuric acid and yielded an oily acid. This acid is a colorless syrup which does not crystallize at 50° C.; it possesses an agreeable fruit-like odor, is lighter than water, little soluble therein, and seems to have the formula $C_7H_{14}O_2$ (perhaps isomeric with œnanthylic acid). On account of the small quantity at my disposal I could not accurately determine its boiling point; but this seems to lie between 215°–225° C. The salts which this acid forms with the alkalies are very soluble in water and deliquesce in contact with the air.

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* This precipitate was decomposed with sulphuric acid and a great deal of a tarry substance was thus obtained floating on the liquid. It is soluble in alcohol and ether, but insoluble in water. When the precipitate is boiled with a concentrated solution of pure potassa, sesquioxyd of chromium is precipitated and a yel-

The lime salt is very easily soluble in water; in the dessicator (over sulphuric acid) it dries up, forming a white, anhydrous, crusty mass, which is not deliquescent.

The silver salt is obtained as a flocculent white precipitate. Its composition was ascertained to be as follows:

I. 0·1471 of the dry salt left 0·0667=45·34 p. c. Ag.
II. 0·1078 " " " 0·0486=44·79 " "
III. 0·1727 " " " were subjected to combustion, furnishing 0·2245 grms. of CO_2 and 0·1046 H_2O.

Required by the formula $C_7H_{13}O_2$.				I.	II.	III.
C_7	84	35·44	p. c.	....	....	35·45
H_{13}	13	5·49	"	....	....	6·71
Ag	108	45·57	"	45·34	44·79	....
O_2	32	13·59	"	....	....	....
	237	100·00				

In conclusion, I beg leave to state that want of time and material prevented me from extending my experiments far enough to speak with greater certainty on many points touched upon in this article. Experiments in this direction will, however, be continued in the Laboratory of Prof. Erlenmeyer (Heidelberg), to whom I take this opportunity of expressing my heartfelt thanks for the kind interest and valuable advice which he bestowed upon me during the whole of my investigation.

New York, Nov. 18th, 1867.

lowish oily-looking substance appears which is easily soluble in water. Sulphuric acid decomposes it, and on distillation an oily acid is obtained which seems to be homologous to the above-mentioned acids. The quantity which I obtained of it was not sufficient for an analysis. These acids appear to me to be identical or isomeric with caprylic acid and its next higher homologues.

ART. XI.—*Preliminary notice of a remarkable new genus of Corals, probably typical of a new family,* forwarded for study by Prof. J. D. Whitney, from the Silurian rocks of Nevada Territory; by F. B. MEEK.

AMONG some fossils sent on for investigation, by Prof. Whitney, the State Geologist of California, from the Silurian rocks of Nevada,* there are a few specimens of a new genus of corals, presenting such an extraordinary and interesting combination of characters, that it is thought desirable to call attention to it here.†

The specimens of this fossil contained in the collection, are slender, slightly flexuous, arched or nearly straight, and subcylindrical, excepting near the lower end, where they taper to a point, by which they were probably attached. They may have grown in tufts or groups, but all the specimens yet seen are single, and show no evidences of growing in contact.

To the unassisted eye, the external surface of these corallites, with the exception of obscure annular swellings and constrictions of growth, and faintly marked linear septal costæ, seem to be nearly or quite smooth. When examined under a strong lens, however, it is seen to be beautifully punctate; the punctures being minute, of exactly uniform size, and arranged with mathematical regularity in quincunx, and so closely crowded that the little divisions between them are scarcely equal in breadth to the punctures themselves, and form, as it were, an extremely delicate kind of net work. So remarkable is the appearance of this punctured outer wall, that the first question that suggests itself, on examining it under a magnifier, is, whether or not it may be merely and exceedingly delicate Polyzoon encrusting the whole surface. A clear examination, however, especially in carefully prepared transverse sections, show that the punctures actually pass entirely through the wall, which is very thin, and that they are not due to the growth of the Polyzoon, nor to surface ornamentation.

On grinding away this very thin punctured wall, the septa are seen immediately within, to be stout, equal, straight and very equidistant, but in grinding a little farther in, they are observed to become very regularly waved laterally, *exactly like the septa in the foraminiferous genus Fusulina.* So striking is this resemblance, that it was not until after ascertaining rom cross section, that the fossil has not an involuted strucure, that I could get rid of the suspicion that it might be a new type of *Foraminifera* allied to *Fusulina*, instead of an extraordinary coral.

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* A notice of the discovery of Silurian rocks at this distant western locality has already been published by Prof. Whitney in the Proceedings of the California Academy of Sciences.

† Figures and descriptions of this and the other Silurian fossils from this locality will be given in the second volume of Prof. Whitney's report on the geology of California.

By grinding still farther in (to a depth of about 0·06 inch, in a specimen 0·34 inch in diameter), the lateral waving of the septa already mentioned, is seen to be there suddenly, and so strongly marked, that they connect laterally, in such a manner as to form a kind of complex inner wall between the great central cavity and the outer septate zone. This wall, however, does not completely isolate the septate outer zone from the central cavity, but is perforated by a series of round equal canals, very regularly placed one within each of the lateral curves of the septa, so that those on the opposite sides of each septum alternate with exact regularity, as do those of each of the two rows within each interseptal space. These canals have no similarity to the minute punctures of the outer wall, being greatly larger and very differently arranged. They do not pass *directly* through the inner wall, but are directed obliquely upward and inward, so that as seen in transverse sections of the corallites, they present the appearance of a double row of vesicles cut across.

Both longitudinal and transverse sections show the large central cavity to be without any traces of septa or columilla. From these sections, I was likewise at first led to believe this central portion to be also an entirely open cavity or calice, the whole length of each corallite, but on sending specimens to Prof. Verrill, he called my attention to some obscure appearances of transverse plates in one of the specimens cut longitudinally, and requested me to cut others with the view of ascertaining whether or not these are plates. A longitudinal section of another specimen, however, when carefully polished, reveals no traces of proper transverse plates; but when examined by the aid of a strong magnifier, it shows the whole interior to be occupied by a dense vesicular tissue, the walls of the vesicles being of extreme tenuity. This structure is seen in the interseptal spaces of the outer zone, as well as in the central cavity within.

In regard to the affinities of so remarkable a type, it seems scarcely safe to express an opinion without a better series of specimens for study. Some of its internal characters, as suggested by Prof. Verrill, would seem to indicate remote affinities to the *Cyathophyllidæ* ; but its peculiar perforated outer wall would, on the other hand, appear to remove it from the primary division of corals including that family.

I am therefore led to believe it a new genus, and most probably typical of a new family, in which opinion Prof. Verrill concurs with me. For this genus I would propose the name *Ethmophyllum.*

Among the specimens in the collection under examination, there are apparently two species of this fossil. That considered the type of the genus is larger and more robust than the other, and more conical in form, especially near its smaller end. None of the specimens seen are quite perfect at the larger extremity. One measures 0·37 inch at its imperfect larger end, and seems to have been 2¼ to 3 inches in length. In this there are sixty septa, while its outer septate zone is 0·07 inches wide. Another fragment, however, measures 1·20 inch in diameter at the larger end, and was probably 5 to 6 inches or more in length, with 112 septa at the larger end. This large fragment shows that the septate outer zone does not increase in thickness or breadth in proportion with the size of the corallites, since it is only 0·15 inch broad in this specimen, the increase in thickness of this corallite being made up by the increased size of the non-septate interior. For this larger species I would propose the name *Ethmophyllum Whitneyi*, in honor of Prof. J. D. Whitney, to whom I am indebted for the use of the specimens.

Of the other species I have seen but a single specimen, which is imperfect at both extremities, about 2·15 inches in length, and only about 0·20 inches in diameter at the larger end, and 0·15 at the smaller, with some 24 to 28 septa. In addition to its much more slender form, it differs from the other species in having its septa so strongly waved laterally, as almost to divide the interseptal spaces into cells, nearly to the outer wall. For this, if it should prove to be a distinct species, I would propose the name *Ethmophyllum gracile.*

The specimens were all obtained at Silver Peak, Nevada, and were discovered by Mr. Clayton.

ART. XII.—*Note on the shell structure and family affinities of the genus Aviculopecten;* by F. B. MEEK.

IN several former publications, I have alluded to the analogy, in some of their characters, between the genera *Aviculopecten* and *Pterinea;* particularly in the nature of their broad, furrowed cardinal plate or area, without any well defined cartilage pit. After examining the shell structure of several species of *Aviculopecten*, sometime since, without being able to detect any traces of the peculiar prismatic outer layer, so characteristic of the various genera of the *Aviculidæ*, I was led to regard this group as most probably belonging to the *Pectinidæ* and as holding in it a somewhat parallel position to that of *Pterinea* in the *Aviculidæ*.

Some examinations, however, that I have recently had an opportunity to make, of the structure of several species of *Aviculopecten* apparently in a good state of preservation, collected by the Nebraska survey under the direction of Dr. Hayden, seem to show that these shells have (when well preserved) an outer prismatic layer of shell as in the *Aviculidæ*, and not the structure of the *Pectinidæ*.

The little experience I have had in making such examinations of the structure of fossil shells, has led me to the conclusion, that *negative evidence* should be received with great caution in such cases, since these shells very often have the structure entirely obliterated during the process of fossilization. In addition to this, it is probable that they are liable to have the very thin outer prismatic layer entirely exfoliated, so as to leave the surface markings tolerably well defined on the laminated portion just within, which is then very apt to be mistaken for the original surface of the shell. Those I have just examined, with one exception, appear to consist entirely of the thin outer layer, the laminated inner portion having been doubtless dissolved away after the shells were embedded in the matrix. They consist of the following species, and show what I am led to regard as a prismatic structure very clearly, viz., *Pecten neglectus* and *P. Hawni* Geinitz; both of which have all the external characters at least, of the genus *Aviculopecten*, and of course are not true Pectens; also *Aviculopecten Coxanus* M. & W. and *A. occidentalis* Shumard, the latter being well known to have the flat striated cardinal plate and internal characters, as well as all the other peculiarities of the typical Aviculopectens. The others are as yet only known to me from what is believed to be the outer layer alone, which is too thin and fragile to bear polishing, but when a fragment is carefully cleaned with a camel hair pencil, and examined under the microscope, by transmitted light, the structure alluded to can generally be seen with little difficulty, without any farther preparation. In these, I have not seen the flattened cardinal plate of the genus, but its absence is doubtless due to the fact that it was mainly or entirely composed of the wanting inner laminated portion of the shell.*

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* The only source of doubt in regard to the structure mentioned being really that of an outer prismatic layer, is, that the same has also been seen in the only remaining portion of *Lima retifera* Shumard, from the same bed. This shell is also very thin, and the portion mentioned has all the appearances of being the *outer* layer. In *Lima*, Dr. Carpenter found the *outer* layer to be laminated, and the *inner* to be perforated with tubuli. The question is, whether the structure I have seen is organic, or minutely crystalline.

ART. XIII.—*Correspondence of Prof.* JEROME NICKLÈS, *dated Nancy, France, Oct.* 22, 1867.

On some new Fluorids.—While examining some time since the haloid compounds corresponding to the oxyds of a higher order, I made[*] the discovery that the periodids are less stable than the perbromids, which in turn are less so than the corresponding compounds of chlorine or the perchlorids. These last are the most stable, so much so in fact, that some of them do not act upon gold, while the corresponding compounds of bromine and iodine dissolve this metal with varying facility. From this fact the stability of these compounds may be concluded to stand in inverse ratio to the weight of the equivalent of the halogen which they contain. Another conclusion seems to be derived from these researches, that a tendency to depart from the character of a neutral body and act the part of an acid is developed along with the stability; this is one of the results from my researches on the perchlorid of lead. Fluorine having a lower equivalent than chlorine, I have endeavored by way of control to obtain certain of its combinations which correspond to chlorids or bromids already recognized and studied. The following will show that these new compounds all act like acids. Take for example iron. Sesqui-iodid of iron,[†] Fe^2I^3, has so little stability that it decomposes spontaneously, giving out iodine; and it constitutes, therefore, a good solvent for gold.[‡] Bromid of iron, Fe^2Br^3, has much more stability and Fe^2Cl^3 does not decompose when heated, and will even form double salts, (for example, $2KCl+Fe^2Cl^3+2HO$, of Fritsche. Now I have found that the sesquifluorid of iron is still better fitted to form saline combinations, or fluo-salts, as they are called by Berzelius, who made known a compound, $3KF+Fe^2F^3$, and another $2KF+Fe^2F^3$. I have obtained analogous compounds, both with sodium and ammonium, and with such alkaloids as quinine and brucine. These double salts are more or less soluble in water; at the boiling temperature they decompose, leaving yellow ferruginous flakes. With acetate of lead they give a white precipitate which becomes yellow on heating; on the contrary, the white cloud caused by the nitrate of lead does not become yellow, but dissolves under the influence of heat. Nitrate of bismuth has no effect in the cold, but on heating gives a white precipitate. Ferrocyanid of potassium throws down a blue precipitate, but the sulpho-cyanid of potassium has no action, at least not until the acid Fe^2Fl^3 is displaced by treating its combination with alcohol charged with fluo-silicic gas; in this case, the red color is obtained which characterizes sulpho-cyanid of iron. However, this red color disappears in the presence of an alkaline fluorid; there is formed a white cloud composed of one of the before mentioned fluo-salts, and the liquid contains an alkaline sulphocyanid. Acetate of iron is equally discolored under these circumstances. On operating with fluorid of potassium and concentrated solutions, all the iron is precipitated in the condition of fluo-salt; with liquids more dilute, a little iron always remains in solution.

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[*] *This Jour.*, II, vol. xliii, p. 94. [†] Ib., vol. xli, p. 108. [‡] Ib., vol. xliii, p. 95.

Prussian blue is equally decomposed by the fluorid of potassium, provided a boiling temperature is used. An excess of fluorid of potassium also opposes its formation. Tannin also does not precipitate ferric-salts in the presence of alkaline fluorids; and fluorid of potassium destroys the black color produced by it. This enables us to distinguish ink prepared with nutgalls from that made with aniline colors, or with indigo-carmine. Tannin does not act on sesqui-fluoferrate of potassium, but it precipitates the corresponding ammonium salt. I may add that the precipitate formed by the yellow prussiate is not only blue, but it has a very decided violet tinge. This action may be utilized in the making of colors.

In view of the facility with which *ferricum* separates from all its combinations, when it finds itself in the presence of an alkaline fluorid, it is necessary to admit that the sesquifluorid of iron is a decided acid, a fact which is confirmed, moreover, by its readiness to form saline combinations, with the fluohydrates of the organic bases. What I have just said of iron is equally true of manganese. I have obtained compounds having for their formulas $KFMnF^2$, $KFMnFO$, $2KFMn^2F^2O$, NH^4FMnFO, and in which the fluorid of manganese evidently plays the part of an acid. I shall speak of it in greater detail at another time, only observing now that the perfluorid of manganese seems destined to solve the problem of fluorine, by putting into the hands of chemists a simple and expeditious process for its isolation.

On the pretended diffusion of copper in nature.—The presence of copper has been noticed in many substances since the time (1818) when Bucholz discovered it in the ashes of plants. When, in 1844, Walchner found copper in muddy deposits from mineral springs, it was not long before it was detected in small quantities in the waters themselves. Very recently, a chemist has found it in repeated trials in the mineral waters of Bourbonne, Balarne, etc.,* while another has discovered this metal everywhere and in all mineral and organic substances in which he has looked for it. The process which has led to this wonderful result offers nothing new. Let it be added, however, that the author referred to worked with reagents, the purity of which he had carefully tested and found to be free from copper. The evaporations and calcinations were performed in a platinum dish with a Bunsen's burner.* Impressed with this wonderful diffusion of a metal which is found everywhere save in the reagents employed for finding it, I could not help recalling the process used formerly for the detection of fluorine,† and I was led to a like conclusion as regards the diffusion of copper. In a word, it appeared to me that there was some source of error, and if it was not in the reagents, it must be found in the apparatus, especially the apparatus used for the incineration. "In fact, the Bunsen burners are generally of copper. This metal is said to be volatile when heated in a current of gas. Besides, when such a burner is lighted, the flame is often seen colored blue by the copper which is volatilized."

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* Jour. Pharm., IV, iv, 22.

These remarks in my *Revue des travaux de Chimie*,‡ are founded on facts long since known and utilized in my laboratory, and which experiments upon artificial light, with which I have been occupied, brought to my attention. They have just been confirmed by Lossen,§ who has found that in fact Bunsen's burner is the true source of the copper that has been discovered in many of the residues from incinerations ; for in experimenting with a large number of organic substances, Lossen has, in fact, obtained either some or no copper according as he made his incinerations with a copper, or a glass burner (or one free from copper). Now that this cause of error is found out, many results are explained that appeared strange when they were announced. Of this kind is the grain of copper which Gahn obtained, on reducing to ashes, before the blowpipe, a piece of paper. The fact of normal copper, that is to say, copper in the blood, may be admitted, if the presence of copper in mineral waters is established. But it is necessary to receive with reserve the assertions with regard to copper-bearing mineral waters, inasmuch as the analysts were not aware of the source of error here mentioned.

Magnetic phantoms.—In my work on Electro-magnets, I have stated a process enabling us to fix and preserve the figures which magnets produce when iron filings are subjected to them. These figures are known in France by the name of phantoms, a name given them by the physicist Haldat, of Nancy. To fix them, the phantoms are developed upon a sheet of paper covered over with wax or stearine, then, a little distance above, something is placed sufficiently hot (a cover of a crucible for instance) to melt the wax or fatty substance. This last, when made liquid, rises by capillarity between the grains of the filings, and if the substance is then removed the fatty matter solidifies, sticking together all the metallic particles. These plates can be kept in a frame and under a pane of glass, where they will not be rubbed. They can also be superposed upon one another without injury.

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* Jour. prakt. Chem., xcv, 368.

† This Jour., II, xxi, 395.

‡ Jour. de Pharm. et de Ch., IV, ii, 412.

§ Jour. de Pharm. et de Ch., IV, iv, 21.

To preserve these curves better, the following process has just been contrived, which gives very good results. The author of it is Stanislas Meunier, assistant naturalist at the Museum. The papers on which the phantoms are to be developed is first impregnated with ferrocyanid of potassium. It is then dried and placed above the magnet used in the experiment. The phantom is then developed as before, except that in place of iron filings, magnetic iron sand is employed, a fine variety of which comes from Norway. Over the phantom thus developed, is passed for a very short time (a few seconds) a small quantity of chlorhydric gas, which is received from the upper part of an inverted tunnel, placed above the phantom. As soon as the chlorhydric gas has acted, the iron sand is removed, and the sheet of paper is washed in a large quantity of water. It is then seen that each grain of magnetite has produced a small blue circle on a clear blue ground; and the points together give all the details of the phantom in consequence of the blue compound developed by the decomposition of the yellow prussiate. The plate thus obtained is very strong; once dry it can be placed in a book and preserved indefinitely. It might be thought that iron filings would be better for this process. But Mr. Meunier has found that magnetite is really preferable, since it is not attacked by chlorhydric gas; metallic iron gives chlorid of iron, which soils the proof and can be removed only by many washings. Magnetite, on the contrary, is free from this objection; it serves to condense the chlorhydric gas through a kind of capillary action, and to accumulate it around the points where magnetic attraction has accumulated the most of the iron sand.

For a long time the magnetic phantom was only an object of curiosity. But since the applications of electro-magnetism have become numerous, these phantoms have been found to be very useful. We learn from them, whether the poles of a magnet are, or have been, isonomal or antinomal, isodynamic or heterodynamic, with "points consequents" or not, bifurcate, trifurcate, tubular, circular, etc.[*]

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[*] This Jour., II, xxx, 413.

On the presence of the vapor of water in certain stars.—In the course of his researches on the spectrum of the vapor of water, Janssen thinks he has noticed its presence in several of the stars, among them, Antares, the spectrum of which presents very plainly the lines and bands of the vapor of water. These lines are black, very broad, and have the characteristic position. Janssen has taken into account the error proceeding from the moisture of the air. On the heights of Mt. Etna the air was very dry. The stations where he has made trials are, Etna, Palermo and Marseilles. Janssen has observed evidence of the presence of the vapor of water also in the atmosphere of Mars and Saturn.

On the transparency of the air.—The inhabitants of valleys know that one of the surest signs of rain is the clearness of outline and blue color of the distant mountains. It indicates great dampness in the air. But it may be asked, how does it happen that this dampness aids the transmission of light, while it hinders that of radiating heat, as Tyndall has shown. This question, raised by de Saussure, has again been theoretically solved by Col. Jackson. According to him, the watery vapor dissolves the impurities which are mingled with the air, and thus renders it very transparent. Entering into these ideas, and recalling the large proportion of atmospheric dust of all kinds which later works have made known to exist, De La Rive has concluded that not only does the atmospheric dust become transparent on absorbing the watery vapor, but that further, the water absorbed renders the dust heavier and makes it fall to the ground. De LaRive also admits that if the presence of watery vapor renders the air transparent when it contains dust or organic particles, its presence is no longer necessary for this end in the absence of dust. This explains why in winter, mountains appear so clearly at a distance, even when the air is very dry; why the air is so clear over plains of snow, and why it is always the same on the Peak of Teneriffe in consequence of the east wind. In the warm season, and in the months when organic life has the greatest activity, the air is most charged with this kind of dry vapor, which in calm weather diminishes in so wonderful a manner the visibility of distant objects. Of the various kinds of dust, only those which are soluble in water, for example, common salt, according to Bunsen, are always in the air, even in regions remote from the coasts. These are the kinds of dust which contribute to the fertilization of the soil: a chemist, Barral, has even found phosphates.

According to a meteorologist, Marshal Vaillant, atmospheric refraction has very much to do with these phenomena. In the hot seasons, the air is warmed by contact with the soil, expands and changes its density and refracting power, effects which do not happen when the air is cold. These considerations have induced De LaRive to include the transparency of the atmosphere in the list of meteorological elements, to be regularly observed in order to establish the precise relations which exist between this particular element and all others, such as the pressure, temperature, moisture, the hour of day, and epoch of the year; a kind of observation of interest not only to science, properly so-called, but also perhaps to medicine. With the aid of Mr. Thury, De LaRive has had constructed a photometer designed to measure the variations in the transparency of the air at different seasons. It was made by the instrument makers of Geneva, and has already been for some time in use.

Physiological effect caused by the vapor of mercury.—We learn from Faraday that mercury is volatile at the freezing temperature in a confined atmosphere. The chemists of Holland have observed that an atmosphere becomes destructive to plants if it contains vapor of mercury. The same chemists have recognized that sulphur constitutes a sure antidote in this case. On repeating and confirming these experiments, Boussingault found that the neutralizing effects of the sulphur lay in the formation of sulphuret of mercury. The plants sensitive to mercury resist its action and continue to flourish, if their leaves have just been sprinkled with sulphur. In this case the sulphur at the end of a month takes a dull grayish appearance, due to the sulphuret produced. Sulphur is doubtless a little volatile at the ordinary temperature, and the tension of its vapor is not appreciable; but the results obtained show that the tension is not nul; and as the densities of the two vapors are nearly the same, and as the equivalent of mercury is nearly six times that of sulphur, it is evident that one volume of sulphur is enough for nearly six volumes of vapor of mercury. In an atmosphere where there is vapor of mercury, the sulphur in fragments acts like flowers of sulphur. It becomes covered with grayish spots; then after eight or ten days, the surface takes the appearance of iron; it is covered over with sulphuret of mercury, very adherent, not soiling the fingers, and not easily rubbed off. Boussingault has been able by this means, to give a metallic look to objects cast in sulphur. Observing the vegetable cell languishing in an atmosphere containing traces of vapor of mercury, and on the other hand, seeing the sulphur in a still less quantity dissipating the unhealthfulness caused by the mercury, Boussingult asked himself whether something similar did not take place in the ethereal ocean. "If the poisonous agent, of which the air is the vehicle, is a metal like mercury or some deleterious gases, such as the miasma which emanates from marshes, may we not regard as purifying agents, the sulphur, iodine, ozone, whose presence at times in the atmosphere cannot be questioned."*

Acclimatization of the Ostrich.—We have spoken several times of the attempt made by the society of acclimatization, at different points on the globe, to propagate the ostrich, the feathers of which are so much sought for in commerce. The park for acclimatization at Grenoble has reared several ostriches. But a disease has appeared among them, which has made it necessary to kill quite a number of them. Their legs became weak and unable to support them. Evidently the conditions necessary for the life of the animal, which require much air and liberty, have not yet been realized. The feathers of the killed ostriches have always been very readily received by commerce, and their flesh is good eating. At the Cape of Good Hope, the acclimatization of the ostrich gives very good results, but the feathers are worth about 20 per cent less than those of the wild ostrich.

At Madrid the trials are very encouraging. At the park of Retiro and of Casa del Campo, where there are sandy hills, brooks, trees and pastures, already several generations of ostriches have been grown. But there, as at Grenoble, the ostriches often break their limbs from the weakness of the bones; and the eggs of the birds are also very fragile. It has been remarked that ostrich feathers are of the greater value where there are less woods and thorns in the places where these birds live. It is on this account that the ostriches of the Cape furnish feathers of medium quality, for they are torn off by the thick woods of the region. The farther we go toward the north in the desert and the dry and barren country, the better are the ostrich feathers.

On fossil man.—Sir Charles Lyell in his work "On the antiquity of man proved by Geology," in chap. xv, mentions only two discoveries of human remains in the Alpine diluvium or Post-pliocene, so abundant in the valley of the Rhine, and especially at Alsace, in the two districts of the *Haut-Rhin* and *Bas-Rhin.* The first is that of a portion of a human skeleton found in 1823, by Boué, near the village of Lahr, on the right bank of the Rhine. The bed containing these bones was the alpine diluvium in question (the loess). This diluvium was in an entirely undisturbed state, and presented its characteristic fossil shells. The history of this discovery is known. Cuvier, to whom they were submitted, on recognizing that they were human remains, expressed the opinion that they were from a modern cemetery. This rich collection was consequently neglected and is now lost.

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* Journal de Pharm. et de Chimie, Sept. 1867.

The second was that of a lower jaw-bone with its teeth, found near Maestricht, on the right bank of the Meuse, while sinking a canal. The cut traversed a terrace of gravel covered by loess to a depth of 18 meters, 6 of which were in the loess and 12 below it, in the stratified gravel. In the chasm, great numbers of bones of elephants, oxen, deer and other mammals, were found. The human jaw bone, which is preserved in the museum of the University of Leyden, was obtained at a depth of 5·7 meters, at the contact of the loess and the gravel in an undisturbed bed of sandy clay resting on the gravel.

In the loess of Alsace there have been found, at several localities, fossil bones of animals in large numbers. A naturalist of Colmer, Dr. Faudel, has just found near this village, and in the undisturbed loess, a frontal and a right parietal belonging to the same skull. The spot was in the loess, at the bottom of a trench of five meters. The deposit had there the usual appearance, being undisturbed and in place, without any trace of cracks, or of infiltrations derived from above, and preserved its homogeneity perfect, quite to the superficial vegetable layer from which it was distinctly separated. A large quantity of bones of deer, cattle, elephants (*Elephas primigenius*) and bison were obtained. As to the human skulls, the superciliary regions were quite prominent; the depression between the frontal bones and the superciliary prominence was strongly pronounced, and the frontal sinuses very large. This prominence of the superciliary arches makes the forehead appear more depressed than it actually is; the facial angle could not be measured; Dr. Faudel estimated it at about 75°. On uniting the two bones, the general form of the skull appeared to be prolonged from before backward, a little depressed laterally, and related to the dolichocephalous type. It may be remarked that a part of these characters have been observed also in the skulls of the cavern d'Engis near Liege, of Neanderthal, near Dusseldorf, and in one of the crania of the mounds of Bozzeby in Denmark; and all of them in a skull found in the diluvian sand of Ingelheim and presented to the session of German Naturalists at Giessen in 1864. These fragments of fossil man have been deposited by Dr. Faudel in the museum of Colmar, where many naturalists have examined them.

Universal Exposition of 1867.—Among the novelties that may be seen at the Exposition, are those which relate to primary education. Reports were called for by the minister of public instruction, Mr. Duruy, not only from the primary schools of France, but also from those of other nations. The objects exhibited are of the following kinds:

1st. Specimens of work by the pupils of the primary schools, (penmanship, calculation.)

2d. Plans for the building of school houses.

3d. Drawing by pupils of the primary schools.

4th. Books, apparatus and methods of instruction; general pedagogy; plans for lectures; methods of reading; of writing; of instruction in arithmetic, history, and geography; and instruction in singing.

5th. Instruction in agriculture and horticulture.

6th. Instruction in Natural History.

7th. Needle work of the girls' school.

8th. Arrangement and furniture of salles d'asile.

9th. School libraries.

10th. Gymnastics.

A commission chosen from among the most competent men was charged to classify and examine all the objects. The reports made on this occasion have been printed by the order of the Minister, and form an octavo volume, which is not on sale, but is distributed by the Ministry of public instruction. The work concludes with plates, giving plans for the construction of school houses, including model plans which have been considered the most appropriate for the end proposed. There are also the plans presented by other nations. Finally, there is an interesting report on the protection afforded to children employed in industrial or agricultural work. The Industrial Society of Mulhouse has undertaken this protection on a large scale, and without government intervention. It serves to incite the other industrial villages to similar provisions for the working classes.

Another part of this Exposition relates to the publication of maps in relief of the various chains of mountains in France. They have been made with the greatest possible care, and after a new plan, by Mr. Bardin, Chief of the geographical works at the Polytechnic School. Mr. Bardin has called his work, *Topographie enseignée par des plans-relief et des dessin.* The works and numerous reliefs are exhibited at the Invalides, in the Vauban hall. They will remain there on exhibition during all next year.

Banquet of Chemists.—On April 22d, while the Universal Exposition was in progress, the French chemists offered to the learned strangers a fraternal Banquet. More than 300 persons took part there. Although the *fête* is called "Banquet of Chemists," there were also present physicists, mineralogists, and geologists. The meeting was presided over by the two princes of chemistry, Dumas and Liebig. Toasts were offered by Dumas, Liebig, Balard, and Hoffmann. The presiding officer read a letter written by Chevreul, honorary president, as *Doyen d'age* of living chemists, born August 21, 1786, and professor of chemistry since 1809.

Notwithstanding the difficulty of arranging such a Universal Exposition, because of the great number of exhibitors, the Germans wish to take their turn, and five years hence there may be a universal exposition at Berlin. The present one at Paris covers all the Champs de Mars, an extent of about 112 acres. It is calculated that, as a consequence of the progress of the industrial arts, it would require, five years hence, 150 acres. Berlin has not 150 acres of land, any more than Paris, or London ; and it is possible that it will be necessary to restrict the number of departments, instead of admitting all as heretofore.

Bibliography.—*Traité d'algèbre à l'usage des Candidats aux écoles du gouvernment;* by H. LAURENT, teacher of analysis at the Polytechnic School. One vol. 8vo, 1867. Paris, (Gauthier-Villars).—We have already announced some of he works of H. Laurent, son of the Chemist, Auguste Laurent. He promises to do for mathematics, what his father did for chemistry. More fortunate than the latter, he obtains at least justice among his cotemporaries. His labors in the department of mathematical analysis have earned him the position, which he holds in the polytechnic school.* While developing in his work the programme of study required to enter the military school, he has also introduced new views, and made an entirely original work, which will be followed with profit both by the scholar and teacher. The work is from the press of Gauthier-Villars, successor of Bachelier, who has no rival in France in the printing of mathematical works.

Elemens d'Electro-chimie appliquée aux sciences naturelles et aux arts; by M. BECQUEREL. 2d edit., 1 vol. 8vo, 628 pages. —The first three books in this volume treat of the production of electricity. Then comes electro-chemistry, properly so called, then "les actions lentes," through which the author has realized such interesting discoveries. The work ends with some of the applications of electricity, and especially the electro-chemical treatment of ores, and methods of protecting metals from the corrosive action of sea water. In spite of his 79 years, the illustrious inventor of the constant battery is always at his laboratory at the Museum, and adds each day a new result to his favorite science of electro-chemistry, to which he has rendered so great services.

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* This Journ., II, xvi, 103.

Review of Geology for the year 1864 *and* 1865; by A. Delesse and de Lapparent. 1 vol. 8vo, 279 pages.—This interesting publication appears now for the fourth time. By the care which the authors use to join the facts which they bring forward to those which have been presented in the preceding volumes, they have been able to make this series a history of the progress of geology since 1860. The work is divided into four parts; 1st, Preliminaries; 2d, Rocks; 3d, Rock formations; 4th, Descriptive Geology. The rocks have been especially treated of by Delesse, whose valuable works on the subject are well known; de Lapparent has had charge of the formations; and the other parts have been prepared by the two authors in common.

Les Lois économiques par A. de Metz-Noblat. 1 vol. 8vo, 739 pp.—This volume is a résumé of the course of political economy which the author presented in 1865 and 1866, at the University of Nancy. Little cared for by despotical governments, political economy is a science quite new among the French. It is very little taught in France, and it is only two years since a chair of Political Economy was first established in the Faculty of the Law School at Paris. A. de Metz-Noblat has founded the department at Nancy, and pursues it there with great success. The beautiful volume of which we give account, introduces the reader in a very complete manner, to the science as established by Sully, Colbert, Vauban, Adam Smith, Malthus, Turgot, Condillac, Condorcet, J. B. Say, Ricardo, MacCulloch, and other celebrated names.

La Science et les Savants en 1866, *par* Victor Meunier. 3d year, 1867.—The author exhibits here the same spirit and nerve as in the preceding volume, (this Jour., vol. xli, p. 110). The principal subjects are Heterogeny; Ante-historic times; fabrication of diamonds; aërial navigation; the whole enriched with curious biographical facts for any who are interested in the scientific movement of our times, and the men who cultivate the sciences. Some months since, also, Victor Meunier became publisher in chief of the Cosmos. He impresses his energy on this periodical. At this moment, he is exposing the abuses which have crept into the French scientific organization—abuses which, in fact, are inherent in all human works.

ART. XIV.—*A new Meteoric Iron from Mexico;* by J. LAWRENCE SMITH, Louisville, Ky.

A FRAGMENT of this meteoric mass was placed in my hands by Dr. Joseph Leidy, of Philadelphia, with the following statement of its history :—" Sometime ago, the American Philosphical Society deposited its natural historical collection with the Academy of Natural Sciences. In the collection of minerals there was a special lot of Mexican minerals presented by Mr. Poinsett, who was at one time U. S. Minister to Mexico. The minerals consisted of rich silver ores, &c., among them this specimen of meteoric iron, which was labelled 'native silver, Mexico.' It appeared to be an entire meteorite, exhibiting no where a cut or broken surface; one end, however, was much crushed, as if the specimen had been used for a hammer. The present weight of the specimen is 3,600 grains; it is two inches long, one and a half wide, and one and a half high in the middle, and slopes irregularly toward each end. The face from which the piece sent was cut is hexagonal, and exhibits a partial crystalline arrangement without development by an acid."

Its structure is highly crystalline, and on the cut face of the piece I have, the laminæ of the crystals are over $\frac{1}{16}$ of an inch thick and cross each other at the usual angle. The Widmannstättian figures are very strongly developed by acid. Its sp. grav. is 7·72, and its composition shows the usual constituents in the following proportions:

Iron,	91·103
Nickel,	7·557
Cobalt,	·763
Phosphorus,	·020
Sulphur,	*trace*
Copper,	*trace*

Although this specimen is spoken of as being a complete meteorite, it not unfrequently happens that fragments of larger masses of meteoric iron of a very highly crystalline structure, which have been detached for some time, present the appearance of being complete masses. It is possible that this iron may be a portion of the large mass recently sent to France from Mexico by Gen. Bazaine.

ART. XV.—*Shooting Stars on the morning of November 14th 1867.*

ON the morning of the 14th of November, the periodic meteors were witnessed throughout the whole of the Western Continent. The following accounts give the character and extent of the display. By previous arrangement, the hours from $10\frac{1}{2}^{h}$ P. M., to 2^{h} A. M., were designated for concerted observations for parallax. It was thought that the meteors would be less numerous then than later, and hence more easily identified, and that conformable meteors would be seen at more stations, since their paths would be more nearly horizontal and longer. The publication of these observations for parallax is postponed until they can be compared and reduced.

The air was clear, in most places, though floating clouds concealed some of the meteors. The moon was but two days past the full, and hence the numbers seen, and the brilliancy of the exhibition, were very greatly diminished.

1. *At New Haven.*—At New Haven there were two parties, one upon the roof of Sheffield Hall, composed of Prof. Lyman, Prof. Whitney, Dr. Wright, and several assistants; and the other composed of students of the College, under the direction of the writer, and located upon the tower of Graduates' Hall. The first party gave exclusive attention to observations for parallax, the second counted the numbers visible, although some paths were charted by Mr. O. M. Harger, and the places of some others indicated with more or less precision.

Upon the tower of Graduates' Hall during the first part of the night, that is, from twenty-eight minutes past nine until one o'clock, we had about five observers counting. Each of them had assigned to him a quarter of the heavens to which he was to look. The counting was aloud to avoid duplication. The following was the result for the several quarter hours:

	9 h.–10 h.	10 h.–11 h.	11 h.–12 h.	12 h.–1 h.
1st quarter hour,	..	2	1	10
2d " "	..	2	3	4
3d " "	3	2	2	6
4th " "	0	3	7	2
Hourly number,	6	9	13	22

The total number seen in 3^{h} 32^{m} was 47.* Soon after midnight a dense cloud arose in the west, and before the close of the hour, it had nearly covered the sky.

At one o'clock a new party of observers replaced the former one, and from this time until five o'clock we had about fifteen bservers. The first quarter hour was therefore somewhat inerrupted by the change of watch, but the clouds were even a reater hindrance. The following were the numbers counted n successive quarter hours:

1^h 0^m	to	1^h 15^m	7	meteors;	sky about	$\frac{3}{4}$	covered.
15	"	30	12	"	"	$\frac{1}{2}$	"
30	"	45	12	"	"	$\frac{1}{4}$	"
45	"	2 0	30	"	"	$\frac{1}{4}$	"
2 0	"	15	40	"	"	$\frac{1}{4}$	"
15	"	30	41	"	"	$\frac{1}{8}$	"
30	"	45	45	"	"	$\frac{1}{3}$	"
45	"	3 0	23	"	"	$\frac{1}{2}$	"
3 0	"	15	38	"	"	$\frac{1}{3}$	"
15	"	30	82	"	"	$\frac{1}{5}$	"
30	"	45	145	"	"	$\frac{1}{10}$	"
45	"	4 0	242	"	"	$\frac{1}{10}$	"
4 0	"	15	302	"	"	nearly	clear.
15	"	$27\frac{1}{2}$	462	"	"	"	"

At four o'clock we were frequently losing meteors in our ount in consequence of two or more appearing at the same instant in different quarters of the heavens. The errors from this cause increased until at 4^h $27\frac{1}{2}^m$ it was evident that our results would not be comparable with those obtained elsewhere, nor would they furnish a reliable measure of the intensity of the display. We therefore ceased counting in concert.

At 4^h 30^m one person counted 21 in one minute.

At 4^h 32^m the whole company counted silently for one minute. They gave severally the following numbers of meteors seen; viz., 32, 64, 31, 24, 56, 34, 90, 48, 37, 38, 32, 25. Average 42·6.

At 4^h 34^m, in another minute the results were, 52, 45, 29, 22, 80, 42, 37, 56, 24, 42, 58, 52, 38, 36; average 43·8.

At 4^h 40^m they counted aloud, all together, 60 in a minute.

At 4^h 43^m they counted silently with the following results for the several persons: 32, 34, 25, 30, 15, 17, 16, 20, 15, 25, 44, 27, 26, 19: average 24·6.

At 4^h 48^m the whole company counted aloud in one minute 36 meteors. At 4^h 53^m a silent count gave the following results for the different persons, viz: 23, 13, 12, 9, 14, 20, 14, 12, 14: average 14·6.

At 4^h 57^m, one person counted 11 in a minute.

At 4^h 59^m ten persons counting singly for 65 seconds saw severally, 12, 7, 11, 10, 9, 10, 17, 15, 13, 9; average per minute 10·4.

At 5^h 8^m, seven persons saw severally in a minute, 9, 10, 11, 7, 8, 16, 8; average 9·9. At 5^h 15^m, four persons counted severally in a minute, 4, 3, 7, 4; average 4·5.

At 5^h 18^m, seven persons, counting aloud, saw 10 meteors in the minute. At 5^h 28^m three persons saw singly in the minute 1, 2, 1 ; average 1·3. At 5^h 30^m, four counting aloud saw 11 in all. The dawn was at this time just beginning to add to the moonlight its influence in diminishing the visibility of the meteors.

In order to compare the various numbers in these observations it is necessary to reduce them to a fixed interval, and to allow for the cloudiness of the sky, and the numbers of observers. For the latter purpose I have taken the numbers in columns B and C on page 194, vol. xli, of this Journal, combined them, and changed their form, so as to make the number of meteors seen by a single person in a given time the unit. The following table is the result.

No. of obs.	Met. seen.	No. of obs.	Met. seen.	No. of obs.	Met. seen.
1	1·00	5	3·28	9	4·15
2	1·88	6	3·58	10	4·31
3	2·47	7	3·80	11	4·47
4	2·93	8	4·00	12	4·63

The table may be interpreted thus: eight persons looking toward different portions of the heavens so as to divide the sky symmetrically among them will see four times as many meteors as the average number seen by them individually. I moreover infer from the rate of increase of the numbers that fifteen observers will see five times as many as one.

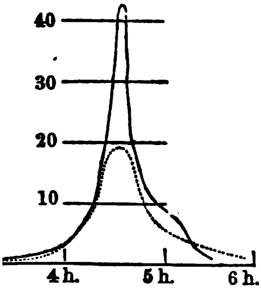
Making allowance thus for the number of observers, and the cloudiness of the sky, I have constructed from our observations the following table. In the column "No. of meteors," I have given the number visible per minute, by a single person at the time indicated (N. H. m. t.)

Table showing the number of meteors per minute visible at New Haven by a single observer during the night of Nov. 13*th*–14*th*, 1867.

Time.	No. of met'rs.	No. of Obs.	Time.	No. of met'rs.	No. of Obs.	Time.	No. of met'rs.	No. of Obs.	Time.	No. of met'rs.	No. of Obs.
h. m.			h. m.			h. m.			h. m.		
9 36½	·06	5	12 7½	·20	5	2 37½	·71	15	4 40	12·0	15
52½	·00	5	22½	Too cloudy for estim'te		52½	·62	15	43	24·6	14
10 7½	·04	5	37½			3 7½	·76	15	48	7·8	12
22½	·04	5	52½			22½	1·36	15	53	14·6	9
37½	·04	5	1 7½			37½	2·01	15	57	11·0	1
52½	·06	5	22½	·24	15	52½	3·23	15	59	10·4	10
11 7½	·02	5	37½	·21	15	4 7½	4·03	15	5 8	9·9	7
22½	·06	5	52½	·53	15	21¼	6·16	15	15	4·5	4
37½	·04	5	2 7½	·72	15	31	21·00	1	18	2·6	7
52½	·14	5	22½	·73	15	33	42·6	12	28	1·3	3
						35	43·8	14	30	3·8	4

According to this table one person should have seen a little more than three hundred meteors between 1^h 10^m and 4^h $27\frac{1}{2}^m$.

eral of the company reported the numbers seen by them ividually during that time as follows, 380, 330, 191, 180, , 335, 92, and 72. The last two were rejected as being exceptional from some cause, and the remainder give an average of 282. An allowance for cloudiness would make the two numbers agree.



The full line in the diagram represents the numbers in the above table. The dotted line represents the numbers deduced similarly from the observations at the Toronto observatory, given below.

During the whole time from $1^h\,10^m$ to 5^h, the following numbers were n by individuals of the company, viz: 813, 888, 635, 913, 790, , 792, 600, and 408; average 731. More or less time in the ght of the shower was lost by every one. If we allow for s cause, for cloudiness, and for the hour from 5 to 6 o'clock, s reasonable to assume that the number for one person for five hours between 1^h and 6^h would be at least 900. This lies about 5000 for the total number visible in the moont. The moon, however, must have concealed one-half or ee-fourths of the whole number. But for that cause there ght have been 10 or even 20 thousand visible.

ery few indeed of the meteors moved in paths which would , if produced backward, cut across the quadrilateral ε, γ, μ . ζ Leonis. I watched carefully those which moved in parls of latitude, and every one seen went accurately from the ter of the quadrilateral. Those which went in circles of tude were not however from a point, but from a line of from ee to five degrees in length. One end of this line had rly the longitude of ζ Leonis and the other had a longitude or two degrees greater than that of ε and μ Leonis.

suspected a tendency of the eye to carry back the more tant tracks to parts of this line too near the zenith. The cannot judge accurately of the proper allowance for the arent curvature on the heavens of an arc of a great circle, en that arc is very nearly horizontal. The nearer tracks, I ught, clustered in the parts of the line near *zeta*. The itude of the line is about 10° 15′. The longitude of the tern end is less than 145°; that of the western end more n 140.°

early all the bright meteors left the characteristic phosrescent train. The few unconformable meteors seen were kingly different in appearance from the conformable ones.

In a few instances, the train lasted for minutes. As the clock struck four, one left a train visible more than four minutes; how much longer I cannot say, as my attention was then diverted. It floated eastward two or three degrees.

2. *At New Haven.*—Prof. Twining furnishes the following observations which are of special value on account of the great care with which he observed and discussed the great shower of 1833.

"After half past three o'clock on the morning of the 14th, I did not again observe the meteors until five o'clock, and, consequently not until their frequency had become very much less than in the interval. Still they were, even then, more numerous than I had witnessed since 1833. In from 5^h to $5^h\ 10^m$ I counted not less than fifty that were conformable, and from that to $5^h\ 22^m$, 50 more,—making 100 (and probably two additional) in 22^m. Afterward, from $5^h\ 40^m$ to $5^h\ 45^m$, there were seen but 13, and in the following five minutes, to $5^h\ 50^m$, only 4. The meteors at five o'clock, compared with those at three o'clock, had no observed difference of magnitude, or flight or duration of trains. From these and the more extended observations of others, made public at New Haven and elsewhere, it appears obvious that the *scale* of this display, compared with what was observed by myself and a multitude of others in 1833, was not—at a rough estimate—more than about one-fifth. This estimate has respect to each of the three following particulars, viz: the frequency of the meteors protracted through a long time; the massive character and brilliancy of the longest and largest; and the duration of the main body or shower. In respect also of the entire agregate of numbers the disparity would appear much greater still. In 1833 there were not less than five hours of full development; while the same this year was but a single hour. Again, in 1833, the *frequency*, prevailing through two hours or more, was estimated by competent observers to from 10,000 an hour to several times that number. Ten thousand an hour was, no doubt, an over cautious estimate; while the aggregate number of 200,000 in seven hours, assigned by Professor Olmsted, although at the other extreme, appeared finally—so far as my own observations and investigations at the time could determine—very much nearer to the truth. Again there were, in this display of 1833, occasional meteors which surpassed, almost immeasurably, any August or November meteors seen in the United States since that occurrence. One such occasional meteor was witnessed by myself, and described at the time; and I saw in the northeast, not long before sunrise, more than one so brilliant and large as to show a well defined circular and fiery disc through the dense glow of twilight which made the train invisible. By a few observers, meteors were seen in the zenith after the sun had risen.

"A remark may be appropriate here respecting the recurrence of November meteors which was witnessed extensively in the eastern hemisphere. The various statemets of this recurrence furnished by competent and eminent observers in Great Britain and on the continent, especially the Astronomer Royal of Scotland and Professor Grant of Glasgow,—also those published in the London Times of Nov. 15th,—and the letters of American missionaries in Turkey and Syria, repeat in description so variously and exactly the massive, brilliant and characteristic features of the meteoric shower in this country, thirty-three years before, that all who carefully observed the latter would, on comparison, no doubt agree that the phenomena of 1866—especially as seen in Syria—were substantially a reproduction of the like in 1833. It does not appear, however, that they were, on the whole, equally extensive and magnificent. On the contrary it is evident that the shower of 1866, at the places from which we have authentic accounts, was inferior to that of 1833, in duration at least, and in the frequency and aggregate number of the meteors,—unless the letter of Dr. Pratt from Marash, in Turkey, to Professor Newton, shows an exception in Western Asia."

3. *At New Haven.*—Prof. Loomis watching alone counted 500 in one hour.

4. *At Germantown, Pa.*—Mr. B. V. Marsh, at Germantown, counted as many as 20 per minute, but had gone into the house at the moment of maximum display. His nephew, Mr. R. M. Gummere, watching with him, reported 39 in one minute as the greatest number seen by him.

5. *At Haverford, Pa.*—Prof. Samuel J. Gummere, of Haverford College, reports about 1000 meteors seen between half past 11 and 4 o'clock. The time of maximum frequency was thought to be a little before half past four. At 4^h 25^m one observer saw 140 meteors in one minute; four, five, or six, being often visible at once. The total number at this time was estimated at from 3 to 5 per second.

6. *At Toronto, Canada.*—The following is an extract from a letter of Mr. G. F. Kingston, Director of the Magnetic Observatory.

" In the paper which I send herewith, I have given the number of shooting stars, during each interval of 10 minutes, together with the average amount of cloud during the interval, expressed in terms of the hemisphere.

"With a view of catching any stragglers in the outskirts of the stream, a watch was kept through the night of Nov. 12th, but the sky was perpetually overcast. Prior to 1^h A. M., on Thursday, Nov. 14, the sky was nearly overcast, and about 20 meteors only were seen between midnight and 1^h A. M. At $1^h 10^m$ systematic counting was commenced from the top of the observatory by four observers working simultaneously. The observers were students of University College, Toronto, several of whom remained through the night in the building, relieving each other from time to time on the tower. Nearly all the meteors proceeded in directions which, when produced backward, passed through the constellation Leo; only about two per cent being not conformable.

"Many were brilliant in spite of the moonlight, but there were no audible detonations.

"Thursday night it was mostly overcast till 4^h A. M., on Friday. Between 3^h A. M., and 4^h A. M., 11 shooting stars were counted by one observer, but none subsequent to 4^h A. M., although the sky then became very favorable. The rapid falling off in the numbers between 5^h A. M., and 6^h A. M., on Thursday, for which the increase in the cloudiness was insufficient to account, shows, I think, that the earth was approaching the outer boundary of the denser portion of the stream."

Abstract of the number of shooting stars seen at the Magnetic Observatory at Toronto, Nov. 14th, 1865.

	1 h. to 2 h.		2 h. to 3 h.		3 h. to 4 h.		4 h. to 5 h.		5 h. to 6 h.	
Portion of the hour.	No. seen.	Cloudiness.	No. seen.	Cloudiness.	No. seen.	Cloudiness.	No. seen.	Cloudiness.	No. seen.	Cloudiness.
m. m.										
0—10	0	0·7	18	0·0	39	0·0	354	0·2	65	0·3
10—20	6	0·7	21	0·0	46	0·0	430	0·2	48	0·4
20—30	4	0·6	24	0·0	61	0·0	237	0·2	42	0·5
30—40	10	0·2	16	0·0	108	0·0	145	0·2	19	0·6
40—50	6	0·1	23	0·0	126	0·0	96	0·2	13	0·7
50—60	18	0·0	21	0·0	180	0·1	83	0·2	8	0·6
Total,	44		123		560		1345		195	
Grand total, 2267										

Between 12^h and 1^h, A. M., the sky being mostly covered with clouds, 20 meteors were seen. The dotted line in the cut on page 81 represents the observations in this table.

7. *At New Bedford, Mass.*—Mr. Robert B. Taber gives for the different intervals the following numbers seen by him alone at New Bedford.

Time.	Meteors seen.	Time.	Meteors seen.	Time.	Meteors seen.
2^h 00^m to 2^h 15^m	15	4^h 25^m to 4^h 30^m	97	5^h 00^m to 5^h 05^m	140
35 “ 55	20	30 “ 35	87	05 “ 10	81
3 37 “ 3 55	54	38 “ 40	48	10 “ 15	70
4 00 “ 4 10	50	40 “ 45	266	15 “ 20	35
10 “ 15	40	45 “ 55	276	20 “ 25	34
15 “ 25	108	55 “ 5 00	110	25 “ 40	52
				45 “ 6 13	43

8. *At Hartford, Conn.*—Mrs. J. H. Trumbull and Miss Trumbull from two (closed) windows, one looking east with a range of 130°, and the other almost exactly covering the N. W. quadrant, began to count a few minutes after four o'clock, and completed their tale of 500 a few minutes after five, the count occupying very nearly one hour. Of course looking through glass the smaller ones were many of them lost. Mrs. Trumbull at one time saw five in motion at one instant.

9. *At Chicago, Ill.*—Prof. T. H. Safford reports the following number of meteors seen at Chicago on the morning of the shower. There were from 8 to 30 observers.

From 12^h 0^m	to	2^h 20^m	128	meteors	were	seen.	
“ 2 20	“	2 53	143	“	“	“	
“ 2 53	“	3 30	653	“	“	“	
“ 3 30	“	4 12	1529	“	“	“	
“ 4 12	“	5 45	857	“	“	“	Total, 3310.

One observer looking to the zenith, counted 420 between 3^h 30^m and 5^h 45^m A. M. These are reported as not included in the preceding count. Prof. Safford noticed that, as nearly as he could estimate, from one-fifth to one-sixth of the stars visible to the naked eye on a moonless night could be seen on that morning.

10. *At Evanston, Ill.*—Mr. Francis Bradley and Mr. Henry Bannister began their watch upon the roof of Heck Hall, about half past twelve A. M., of the 14th, Mr. Bradley looking toward the N. E. and E., and Mr. Bannister toward the N. and N. E. They counted as follows:

	From 12½h. to 1 h.	1h. to 2h.	2h. to 3h.	3h. to 3¼h.	3¼h. to 3¾h.
Mr. Bradley,	6	27	102	102	738
Mr. Bannister,	2	13	61		
Total,	8	40	163	102	738

	3¾h. to 4h	4h. to 4¼h.	4¼h. to 4¾h.	4¾h. to 5h.	
Mr. Bradley,	171	170	61	29	
Mr. Bannister,	98	94	18	21	
Total,	269	264	79	50	In all 1713.

The attention was almost exclusively given to counting, and the numbers are therefore the more valuable. The unconformable ones were very few, not much more than a dozen in all. Two left trains that lasted for three or four minutes. The prevailing tint in all was blue. Many were brick-reddish, while a few were of the latter color on the outside of the train, and bluish in the middle. Mr. Bradley gives the center of the radiant, R. A. 9^h 51^m, Dec. +23. He was looking at the radiant, and saw quite a number of paths within the bend of the sickle, but none of them absolutely stationary like some seen last year.

The numbers seen at Evanston correspond very well with those seen at New Haven. The latter part of the Toronto curve in the diagram on p. 81 represents, however, the variation in the numbers toward the end of the shower better than the corresponding portion of the New Haven curve.

11. *At Ann Arbor, Mich.*—Prof. Watson was prevented by the high wind, which was blowing almost a gale, from making complete observations. The number of meteors counted was as follows:

From 3^h 45^m	to 3^h 55^m,	230 met'rs.	From 4^h 15^m	to 4^h 25^m,	230 met's.
" 55	" 4 5	185 "	" 25	" 35	115 "
" 4 5	" 15	250 "	" 35	" 45	78 "

At times the flight of meteors was so incessant that only a portion could be counted. Prof. Watson noticed particularly that in the vicinity of the radiant point the light of the meteors was of a sea-green tint, with occasionally strong tints of the blue. The position of the radiant point he found at half past four to be R. A. 150° 45′, Dec. + 21° 55′.

12. *At Bloomington, Indiana.*—Prof. T. A. Wylie, assisted by students of the Indiana State University, watched from 9^h P. M. to 5^h A. M. After midnight hardly a star under the second magnitude could be seen in any part of the heavens. It remained nearly uniformly hazy with some slight alterations until morning. From 9^h to 12^h but one meteor was seen; from $1^h$to 2^h, 18; from 2^h to 3^h, 43; from 3^h to 4^h, —276; from 4^h to 5^h, 184. The whole number of meteors counted was 535. Taking into account the state of the air and the light of the moon, they were sure that the tenth, and believe that the fifteenth part were not seen. The greatest number seen in a given time was from 3^h 35^m to 3^h $36\frac{1}{2}^m$, averaging $14\frac{2}{3}$ per minute.

From	3^h 37^m	to 3^h 39^m	they saw	3	per minute.
"	39	" 40	"	5	"
"	40	" 41	"	6	"
"	41	" 46	"	$11\frac{3}{5}$	"
"	46	" 47	"	11	"
"	47	" 50	"	10	"
"	50	" 55	"	7	"
"	4 0	" 4 5	"	$4\frac{2}{3}$	"

One meteor was noticed by Prof. Kirkwood apparently stationary.

13. *In Alleghany Co., N. Y.*—Mr. J. N. Flint at Canaseraga, counted 460 in the hour from half past four to half past five o'clock.

14. *At Topeka, Kansas.*—Prof. John D. Parker saw 30 in the quarter hour from 5^h to $5\frac{1}{4}^h$ A. M., and 31 in the next quarter hour.

15. *Albany, N. Y.*—The following account of the observations at the Dudley Observatory is furnished by the director, Mr. G. W. Hough.

"On the night of the 12th Nov. a general watch was kept up, but as it continued cloudy during the whole time, no meteors could be seen. On the night of the 13th, however, it was perfectly clear until $11\frac{1}{4}$ P. M., after which until 3^h 45^m A. M. the sky was more or less obscured by broken clouds. During the evening, for the greater portion of the time, two persons were on the watch continually. The observations were made by Messrs. Simons, Brandt, McClure and myself.

"A little after 1^h A. M., ten meteors of considerable brilliancy were noted, emanating from the direction of Leo, and passing through the constellations Gemini and Canis Major. Clouds now obscured the greater portion of the eastern heavens.

"At 1^h 25^m A. M., two of great brilliancy, more than double the size of Sirius, shot almost simultaneously from under the eastern clouds, one moving toward the south and the other toward the northwest, producing phosphorescent lines along their course, and before disappearance emitting luminous trains. From this time until 3^h 45^m A. M., the clouds prevented all observations.

"At 3^h 50^m the eastern sky was nearly free from clouds. The meteors now began to appear with considerable frequency, and we made arrangements for locating their paths, by means of the comet-seeker and chart; as also to record the times of flight by magnetic registration on the Chronograph.

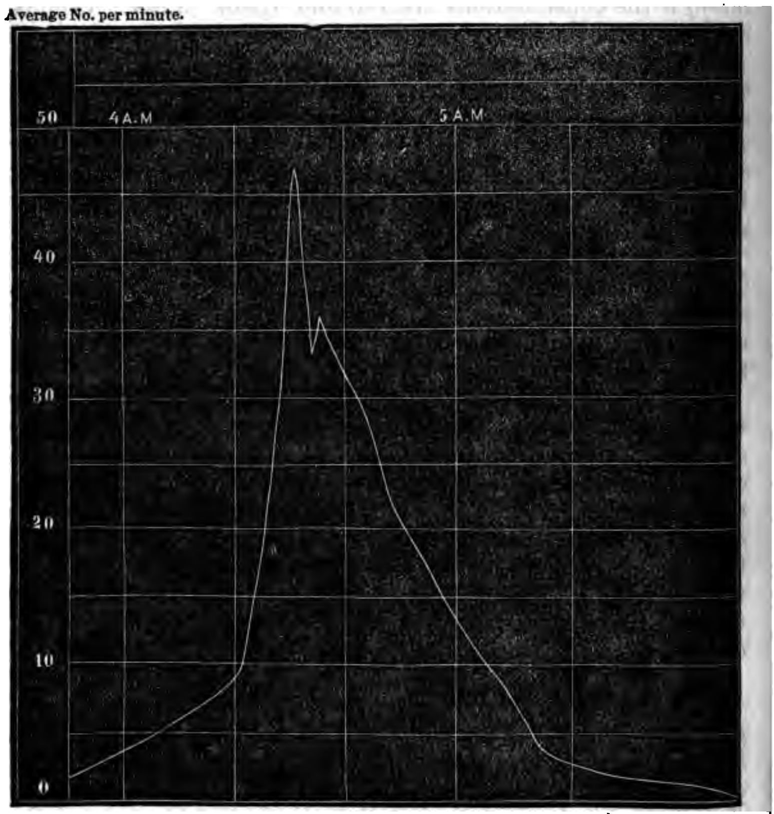
"We had located two or three, but during the time necessary to read the circles and make the necessary notes, 8 or 10 escaped, and as they continued to fall with increasing frequency we decided to abandon the location of paths, for unless they were recorded chronographically at other stations they could not be identified. We thought, however, to continue the record of the time of appearance and time of flight; but in a few minutes the number increased so rapidly that we found it impracticable, as it was impossible to record all. We desired, moreover, to see this magnificent display to the best advantage.

"The following notes were made at the time:

"4^h 16^m A. M.—They fall with increased frequency, and are of greater brilliancy. Four brighter than second-magnitude stars shot in quick succession to the northwestern horizon. They are radiating from Leo in all directions. 4^h 18^m.—One brighter than Jupiter, of a beautiful and purple color, shot toward the southwest near the full moon. It left a train visible for fifty seconds. 4h 33m.—Partially clouded over. 4h 41m.—Clear sky. 4h 48m.—One larger than any previously seen, shot from Leo toward the eastern horizon.

"5h 01m.—Two of dazzling brilliancy emanated simultaneously from the same point, and passed through Ursa Major, disappearing at the northern horizon. The trains remained visible nearly a minute. 5h 07m.—A very brilliant one passed from Leo northeast, its path being very near Arcturus. It left a train visible sixty-five seconds. 5h 08m.—Clear in the zenith and east, but cloudy in the west. Many meteors pass through Ursa Major. 5h 20m.—Cloudy. 5h 38m.—Clear in the east. 5h 41m.—A very brilliant one moved toward the north, leaving a broad train, which remained visible sixty-seven seconds.

Diagram showing the average number of Meteors per minute, observed at the Dudley Observatory, Albany, Nov. 14th, 1867, from 3 h. 50 m. A.M., to 5 h. 50 m. A.M.



"The following table shows the number of meteors counted; all emanating from the direction of the constellation Leo.

Dudley Observatory Mean time.	No. of Meteors.	Mean time.	No. of Meteors.	Mean time.	No. of Meteors.
$4^{h}\ 05^{m}$ A. M.	37	$4^{h}\ 35^{m}$ A. M.	512	$4^{h}\ 53^{m}$ A.M.	1000
4 25 "	180	4 38 "	610	4 59 "	1100
4 30 "	312	4 41 "	708	5 08 "	1200
4 32 "	406	4 44 "	802	5 22 "	1247
4 33 "	440	4 48 "	900	5 54 "	1301

"It appears from an examination of the foregoing table, that the maximum of frequency occurred at $4^{h}\ 31^{m}$ A. M.; and the rate of fall was forty-seven in one minute.

"The annexed diagram exhibits the progress of the shower. It shows the rate of fall from minute to minute from $3^{h}\ 50^{m}$ to $5^{h}\ 50^{m}$ A. M., as deduced from the preceding observations. When the shower was near its maximum, six or eight meteors would frequently shoot out simultaneously, and generally they appeared to fall in groups of two or more at a time. One of the most noticeable features, however, was the permanence of the train after the meteor had disappeared. In a number of instances it remained visible more than one minute by actual determination with a chronometer."

16. *In California.*—A writer in the San Francisco Times states that nearly 500 meteors were counted in half an hour between one and two o'clock, on the morning of Nov. 14th. A correspondent of the Sacramento Union, states that from fifteen minutes before two o'clock, they gradually decreased in numbers until he retired, at five o'clock, when an occasional one could be observed. Dr. Harkness states that when he was first notified of their appearance at 20 minutes past one o'clock, they were falling at the rate of about fifty per minute.

17. *At Chihuahua, Mexico.*—Mr. George L. MacManus of Chihuahua writing to Mr. B. V. Marsh says, "when we first observed the meteors we attempted to count them. We counted three hundred and eighty in about ten minutes but then they fell so thick and fast that we gave up in despair. . . . . Often twenty or thirty at a time were seen."

18. *In Europe.*—There appear to have been no unusual numbers of meteors seen in Europe on the morning of Nov. 14th.

19. *Geographical limits of the shower.*—For the reasons mentioned in the Jan. No. of this Journal, last year, (vol. xliii, p. 88), the eastern limit of the regions on the earth's surface in which the shower was visible must have been a line running S. 18° W. through the center of the N. Atlantic ocean, and through South America a little east of its center, The western limit was a line in the Pacific ocean running N. 24° W. a

little east of the Sandwich Islands. Just beyond these limits a small display may have been visible. In the Sandwich Islands any meteors that may have been seen would have the peculiar characteristics of those seen in the Azores last year.

20. *Personal equation.*—An examination of the numbers reported in the New Haven observations shows that there is a very notable difference in the numbers seen by different persons at the same place, during a given interval. This is due, in part at least, to the unequal attentiveness and quickness of eye of the observers, and to the direction toward which they are looking. The person of a company who sees the largest number of meteors during one minute is, moreover, not always he who sees the largest number another minute.

Hence we cannot rely implicitly upon the counting of one person to determine the minor variations of density of the stream of meteoroids, as we pass through it. Again, the numbers seen at different places by single observers cannot be compared with the same confidence as the numbers seen by two parties of considerable size. Individual peculiarities may reasonably be expected to disappear to a certain extent in the latter case.

21. *Form of the curve of intensity.*—The three curves given in the diagrams above, as well as all the other observations of 1867 and 1866, show that the diminution of the intensity of the display was less rapid than the increase. This is due, evidently, to the gradual increase in the apparent altitude of the radiant toward morning. A tolerable correction might be made for this cause by dividing the numbers expressing the intensity of the display by the sine of the altitude of the radiant.

22. *Breadth of the radiant in Latitude.*—That the radiant should not have breadth in latitude seems necessarily to follow from the very small thickness of the stream. In one hour the earth moves about 20,000 miles in a direction perpendicular to the plane of the meteor group. The duration of the shower is limited to a few hours at the utmost, and in its greatest intensity to one or two hours. But if the radiant has a breadth in latitude of only a single degree, it would seem to follow that the group is more than a million of miles in thickness, which would give us a shower lasting for days.

23. *Length of the radiant in longitude, and distribution in longitude of the perihelia of the orbits of the meteors.*—That the radiant has length implies that the perihelia of the orbits are distributed considerably in the plane of the stream. If the radiant is 5° long the direction of the relative motions of the meteors from the two ends of the radiant differ 5°. The

directions of their absolute motions would differ still more, in fact more than 8°. This difference, moreover, implies a distribution of the perihelia of the orbits of the individual meteoroids along an extent of about 17° in the plane of the group.

It hence follows that when the group is at *aphelion* it will be scattered over an arc of similar extent on a circle whose radius is the aphelion distance. Seventeen degrees on such a circle would be nearly nine times the distance from the earth to the sun.

24. *Comet of* 1366.—It was suggested in the May No. of this Journal (xliii, p. 298) that the Comets of 1866 and 1366 might prove to be identical. I had not then access to E. Biot's translation of the Chinese accounts. The following is an English translation from Biot (Additions to *Connaissance des Temps*, 1846, p. 49).

"...... 1366, Oct. 25th, (period *Tchi-tching*, 26th year 9th month, day *Keng-tseu*) a comet was seen near the star δ Ursae Majoris, within the circle of perpetual apparition. Its color was like that of a handful of flour; it was nearly as large as a bushel measure. It went southeast, and passed near the group β, γ, Draconis. The day *Sin-tcheou* (Oct. 26th) it was at the $18\frac{50}{100}$ degree of the stellar division *Ouei* (determinant star μ^2 Scorpionis). The day *Fin-yn* (Oct. 27) it was at the $2\frac{50}{100}$ degree of *Niu* (determ. ϵ Aquarii). The day *Kouei-mao* (Oct. 28) it was at the $9\frac{90}{100}$ degree of *Niu*. The day *Kia-tchin* (Oct. 29) it was at the $0\frac{80}{100}$ degree of the division *Hin* (determ. β Aquarii). The day *Y-sse* (Oct. 30) it went from the enclosure of *Tse-wei* between the stars δ Ursæ Majoris and ϵ Ursæ Majoris. It was in the division *Tchin* (determ. γ Corvi): it went to the southeast and passed near the group β, γ, Draconis; it crossed the groups β, δ, Lyræ and η, θ, Lyræ; removed from the stellar division *Hiu* (determ. β Aquarii); passed near the western star of *Loui-pi-tchin* (small stars in Aquarius and β Piscium); and began to disappear."

It is evident that unless the writer has repeated his story, two comets are here spoken of. The following explanation of the account is suggested. One comet passed from δ Urs. Maj. rapidly across the heavens through Draco and Lyra into Aquarius, where it was seen on the 29th of October. The next night it was not found there, but another comet was discovered in Ursa Major and was assumed to be identical with the first. The second comet traversed very nearly the same route as the first in a period not given.

Both described paths which may be called with entire propriety *conformable*, being from a radiant several degrees west of Leo. This radiant would have a longitude of about 135°, and would be four or five degrees from the longitude of what has been styled the *apex of the earth's motion*, i. e., the point to which the earth was then moving. The earth passed the node of the group on the morning of either the 22d or the 23d of October, and one of the most remarkable of star showers was witnessed in Europe between the hours of matins and primes.* The two comets traversed in the sky a course along which the meteor group would, if visible, have been seen projected.†

If this explanation of the Chinese account be the true one, we cannot say that either of these two comets is the same as Comet I. 1866. We are led to the conclusion that the group contains two, and probably several comets of respectable size.

Accounts from Prof. Leonard, of the Iowa State University, and from Prof. Young of Dartmouth College, and also the report from the U. S. Naval Observatory at Washington, have reached us too late for this article. Numerous observations for parallax made at Washington, Germantown, Haverford, the Palisades, Poughkeepsie, Stamford, New Haven, Williamstown, Hanover, and Cambridge, need comparison and reduction before they can be of use. We hope to resume the subject in a future number. H. A. N.

Art. XVI.—*Notice of a peculiar mode of the occurrence of Gold and Silver in the Foot-Hills of the Sierra Nevada, and especially at Whisky Hill, in Placer county, and Quail Hill, in Calaveras county, California;* by B. Silliman.‡

In the search for ores of copper which occurred in California in what is now known as the "Copper Belt" of the Lower Sierras, deposits of "Iron Rust," as they were called by the miners, were observed at numerous points far below the range of the main gold belt of the Sierras. Several of these ochraceous deposits had been previously "located" by prospecting miners for gold, before there was any knowledge, or suspicion even, of the existence of ores of copper in connection with them. It was a matter of common observation that certain gulches, or watercourses in the neighborhood of these rusty deposits, were rich in placer gold, having been worked for gold from an early date. The search for copper in this kind of deposit was not commercially successful, although there were shipments of green and blue carbonates of copper, red oxyd and metallic copper, to a limited extent from both the localities here referred to, the metal from which was known to contain a notable value of gold and silver, stated to be about fifty dollars to the ton of ore. This search for copper has, however, opened up these deposits so as to display their character in a conspicuous manner.

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* This Journal, xxxvii, 383.

† The comet of 1366 is described by Pingré, but owing to an error of the month the date is carried forward the cycle of 60 days into August.

‡ Proceedings California Academy, April 15, 1867.

The rocks appear to have been originally talcose and chloritic schists, sometimes micaceous, enclosing masses of argillite, and of quartz which appears to have been massive enough at certain points to assume the character of a vein, and parallel to the stratification which has the usual northwestern strike and easterly dip of the region. All this mass of material, which at Quail Hill is certainly three hundred feet wide, and possibly twice that, and with a linear extent exceeding one thousand feet, appears to have been very highly impregnated or mineralized by sulphurets, chiefly of iron, with a portion of copper, zinc and lead. The sulphurets have undergone almost total decomposition throughout the entire mass, leaving soft ochraceous deposits of a rusty red and yellow tint, and staining the rocks with brilliant colors, a peculiarity which the miners have characterized by the name of "Calico rocks." This decomposition or oxydation of the sulphurets has extended as far as atmospheric influence penetrates, or probably to a point where water is permanently found, which at Quail Hill is assumed to be about 170 feet below the outcrop of the mass or crest of the hill. Dykes of porphyry and of other rocks, commonly called intrusive, are seen dividing these great ore channels in a direction conformable to the line of strike. But the decomposition which has affected other portions of the ore channel appears also to have changed them, for they are found to be reduced completely to the condition of kaolin and lithomarge, or kindred alterations of feldspathic rocks. The outlines of the feldspar crystals are still easily distinguished, although the mass of the dykes is completely friable. The zinc blende which is found in small quantities at Whiskey Hill, and the vitreous copper also to some extent, appear to have escaped decomposition. The copper ores seem to have been confined to a portion of the deposit, as is indicated in the section exhibited, while the auriferous sulphuret of iron has been co-extensive with the ore channel, the cubical cavities left by the decay of its crystals being found in all the outcrops both in the quartz and in the 'calico rocks' resulting from the decomposition of feldspathic and talcose or chloritic constituents.

Accompanying the entire mass of decomposition at both localities occur both gold and silver, disseminated with remarkable uniformity in all parts of the ore-bearing ground. At Whiskey Hill, films of metallic silver are visible upon the talcose masses stained green by malachite or chrysocolla; the gold is rarely seen in situ, being mostly obscured by the very rusty and highly-stained character of the associated materials. But it is rare that, on washing a small quantity of any of the contents of these great deposits, gold is not found in angular grains or small ragged masses, from the size of a few grains' weight, to impalpable dust. Nuggets of several pennyweights occur occasionally. This gold has evidently accompanied the sulphurets and been left in its present position and condition by their decomposition. There can be little doubt that the gold of the gulches adjoining these deposits has been derived from them. At Whiskey Hill, the gulch gold ceases to be found as soon as the limits of this deposit are passed, and the same is true at Quail Hill. The occurrence of deposits of this nature throughout the range of the foot-hills seems to offer the best solution which has suggested itself of the origin of the placer gold which is found in situations so far removed from the gold belt of the upper Sierras, and away from sources usually recognized as those to which placer gold may be referred.

Experiments made by myself and by others on a considerable scale, the details of which will appear elsewhere, show that the amount of the precious metals disseminated in the average mass of vein stuff and decomposed materials of every name at Quail Hill, is considerably in excess of the general average tenor of gold veins in California. The mean of my own trials gave to the ton of 2,000 lbs. by assay:

Gold	$35.14
Silver	15.08
	$50.22

While from the working of carefully prepared averages in considerable quantity by milling process, the tenor of the precious metals was:

Gold	$29.18
Silver	5.91
	$35.09

The extreme friable condition of the entire yield of these auriferous materials renders their extraction and treatment easy and comparatively inexpensive.

At Whisky Hill, a mill of forty stamps has been set up which is now running with satisfactory returns—the cost by contract of delivery of the ores to the mill being stated at forty cents per ton, the cost of mining and treatment in mill being considerably less, it is said, than one dollar per ton, the amount treated being five tons to each stamp.

The chemical results of the extensive decomposition of metallic sulphids which has in former times occurred at these localities, offer an interesting problem in chemical geology. The sulphur has been removed chiefly beyond doubt as sulphuric acid, which has combined with iron and copper to form sulphates of these metals. These have for the most part disappeared, being washed out by the atmospheric waters, and have followed the drainage of the country. At Whisky Hill I found the sulphate of iron, (Coquimbite) sulphate of copper, (Cyanosite) and alum. The water of the shaft contains copper enough to redden the iron tools. At Quail Hill considerable masses of heavy spar are found, formed probably from the action of soluble sulphates upon witherite. No gypsum was observed at either locality.

The mineral species found at Whisky Hill, are as follows:

Metallic Gold.
Metallic Copper.
Metallic Silver.
Red Copper.
Malachite (green carbonate of copper).
Azurite (blue carbonate of copper).
Chrysocolla (silicate of copper).
Cyanosite (blue vitriol).
Copper Glance (Vitreous copper).
Zinc blende.
Galena.
Iron pyrites.
Alum.
Coquimbite.
Heavy Spar.
Hematite (chiefly the earthy varieties).
Kaolin.
Lithomarge and various aluminous and magnesian silicates resulting from the decomposition of the chloritic and talcose rocks.

The list of species is about the same for the deposit at Quail Hill.

The line of division between the ore-bearing ground in these great ore channels, and the country rock is quite distinctly seen on both eastern and western outcrop at Quail Hill, and on the western at Whiskey Hill. At the former place it is a dark bluish porphyritic rock, probably metamorphic of a sandstone or siliceous sediment. The outcroppings resemble those of many quartz veins, and I find the moss-covered portion of this quartzose matter full of cavities, resulting from the decay of pyrites, and yielding, by assay, three to five dollars to the ton in bullion.

From all the evidence presented, we seem justified in regarding these remarkable metallic deposits as segregated veins, holding a pretty uniform and large percentage of gold and silver, associated with and derived from the decomposition of extended masses of metallic sulphurets and quartzose matter, and carrying, at times, ores of copper, the commercial value of which is, however, entirely subordinate to that of the precious metals which are found to characterize these veins or ore channels.

San Francisco, April 15th, 1867.

ART. XVII.—*Observations on Skylight Polarization in Nebraska;* by EDWARD A. CHASE.

THE observations with the Savart Polariscope, of which a partial report was published in the September number of this Journal, were continued through the summer and a portion of the autumn.

On account of the interruption caused by rain, clouds, and the camp duties of the Geological Survey, I was unable to accomplish so much as I desired; but the low, unbroken horizon of the prairies appeared peculiarly favorable for observations upon the neutral points, and the following brief summary, may, perhaps, be worthy of record.

No. of days on which obs. were made,	44
" of observations,	62
Observations of Arago's neutral point,	44
" " Babinet's " "	59
" " Brewster's " "	19

Simultaneous Observations.

Arago's and Babinet's n. ps.	35
Arago's and Brewster's "	1
Babinet's and Brewster's "	17
Arago's, Babinet's and Brewster's,	6

When Babinet's and Brewster's neutral points were both visible,

Brewster's appeared most distinct,	6
Babinet's " " "	5
Both were equally distinct,	6

Thirteen of the observations were made when Brewster's neutral point was below the horizon.

I.—*Editorial Correspondence.*

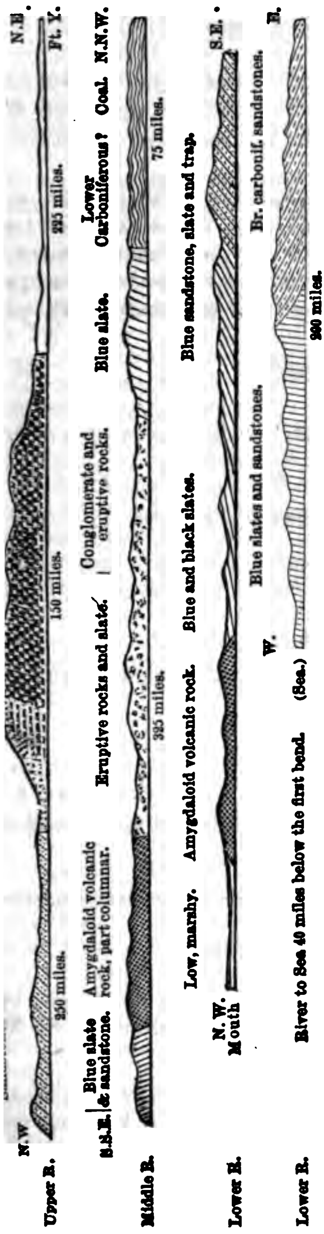
Explorations in Russian America; by W. H. DALL, (from a letter addressed to J. D. DANA, dated Russian Extension, St. Michaels, R. Am., Aug. 13, 1867).

Some account of last season's work in this country may not be devoid of interest to you. Since last September I have crossed Russian America in its widest part from the sea nearly to the British boundary line, and have carefully examined the geological formations of the country.

The Youkon river, the great central artery of this portion of the territory, enters Alaska about midway between the Polar Sea d Mount St. Elias. From this point about fifty miles it is joined by the Porcupine river, and I have traversed its entire course, thence some 1300 miles to the sea south of Norton Sound; being the first trip ever made from Fort Youkon (H. B. Co.) to the mouth of the river. It describes a kind of gigantic "S" through the territory in question; from the Porcupine river at the upper end of the "S" to the first bend at Koyoukuk in a southwesterly direction 630 miles; meeting about 375 miles from Fort Youkon, the Tananá river from the southeast, and at the bend the Koyoukuk river from the north; from this point to the second bend in a south (slightly easterly) direction 450 miles, meeting the Takitesky river from the northeast, and the Anoik river from the northwest; from the great bend to the sea, in a northwest direction, about 250 miles, terminating in a tremendous delta, nearly as large as that of the Ganges. I have obtained specimens of rock and fossils sufficient to prove the ages of the strata, but a very few words will serve for a general description.

The annexed diagrams, though having no pretensions to accuracy in detail, will give you some idea of the rocks.

Starting from Fort Youkon and going down stream, we have on either hand, low land sparsely wooded with spruce, poplar, birch and willow, with low hills in the distance, gradually increasing in height and coming closer to the river, where they finally come together 225 miles below Fort Youkon; and the river which previously has been very winding, full of sloughs and large islands, and from three to nine miles wide, here becomes narrow, deep, and rapid, with one channel. These


Upper R.
N.W.
N.E.
Ft. Y.
250 miles.
150 miles.
225 miles.
S.S.E.
Blue slate & sandstone.
Amygdaloid volcanic rock, part columnar.
Eruptive rocks and slate.
Conglomerate and eruptive rocks.
Blue slate.
Lower Carboniferous?
Coal.
N.N.W.
Middle R.
325 miles.
75 miles.
Lower R.
N.W. Mouth
Low, marshy.
Amygdaloid volcanic rock.
Blue and black slates.
Blue sandstone, slate and trap.
S.E.
Lower R.
River to Sea 40 miles below the first bend.
(Sea.)
W.
Blue slates and sandstones.
Br. carbonif. sandstones.
E.
280 miles.

mountains are known as the Ramparts, and come close to the water's edge, having an imposing appearance, though probably not more than 1500 to 2500 feet high. They were entirely composed of Azoic rocks, of which a silvery greenish rock of talcose *appearance*, but very hard, predominates. Quartz, in seams, slates and quartzite rock are abundant; and a rock resembling granite, but with a superfluity of feldspar, and no mica, rarely. The slates generally have a northwesterly dip.

True granite appears only once, near the termination of the Ramparts, and forms a ledge extending across the river and making a rapid; not, however, a dangerous one. Fifty miles or less, below the rapid, the Ramparts terminate, the Tananá river (or river of mountains) comes in and from this point to the mouth, as a rule the river is wide, with the right bank high and the left bank low, but occasionally with mountains in the distance or a bluff on the river. From the end of the Ramparts to Koyoukuk river (250 miles) the right bank presents in their order: conglomerate, quartzite, bluffs of yellow gravel, blue talcose slate, conglomerate, hard blue slates and quartzose rocks, blue sandstones and a soft green rock (Plutonic) with light stellate spots in it. Granite is very rare and mica also. I have found fine specimens of obsidian on the beach and just above the Ramparts, pebbles of Niagara limestone with its characteristic fossils. From the bend we find the following strata: blue sandstone, (unfossiliferous) brown sandstone in beds at least 500 feet thick, containing vegetable remains, in some layers and rarely, casts of mollusca, all as far as I have collected, Lamellibranchs. Thirty miles below the bend, is a small contorted seam of coal between two thin layers of shale containing very poor vegetable remains, and underlaid by the brown sandstone which also overlies the blue sandstone; which in its turn I think covers the blue slates. The coal seam is very limited, being on the extreme point of a bluff and the greater part of it has been denuded. The fossils are very poor, vegetable, and resemble Fuci. The coal is of good quality, bituminous, non-caking, and leaves a gray ash. The seam is 16 in. wide.

The sandstones continue down the river some 45 miles, more generally with a N.W. dip, and always in gentle undulation, sometimes continuous for miles, and often broken short off. Below, the rocks for 300 miles, are slates and eruptive rocks of a pink color, sometimes containing spathose minerals. The formation changes, at the Russian mission, from hard blue slate, to a volcanic rock, full of almond shaped cavities which are empty; but certain parts of the rock are quite solid. It is black and contains minute crystals (of ? olivine.) [It is roughly columnar on Stuart's island, Norton Sound, in five sided columns, on the beach.] From this to the sea, the banks are mostly low, but when they approach the river they are invariably blue hard slaty sandstone or sandy slate: the rock passing from one into the other imperceptibly. This formation extends to St. Michaels, nearly where the fore-mentioned volcanic rock takes its place, and continues up the shore of Norton

Sound some 30 miles, when it it is replaced by the hard slates and sandstone, and I have followed them up for 30 miles more to Unalákleet river. Here you cross in winter to the Youkon, 200 miles of portage.

The entire country is sprinkled over with remains of Pliocene animals, ? *Elephas*, *Ovibos moschatus*, &c. Beds of marl exist near Fort Youkon, consisting of shells (fresh water) still found living in the vicinity. The Kottó river, emptying into the Youkon above Fort Youkon, is held in superstitious dread by the Indians on account of the immense number of fossil bones existing there. The Inglutálic river emptying into Norton Sound, has a somewhat similar reputation.

The collections this year are not so large as if I had had some one else in the country to assist me, but they are more than made up by the great success of Mr. Bischoff at Sitka. My own collections amount to some 4,550 specimens, filling eight cases.

I have journeyed with the thermometer from 8° to 40° below zero, with dogs and sleds, and in the summer with it up to 110° have paddled 15 hours a day. I have travelled over 2,500 miles since last September, mostly in canoes or on snowshoes.

I have carefully examined the country over which I have passed, for glacial indications, and have not found any effects attributable to such agencies.

My own opinion from what I have seen of the West coast, though yet unproved, is that the glacier field never extended in these regions to the westward of the Rocky mountains, although small single glaciers have and still do exist between spurs of the mountains which approach the coast. No boulders, such as are common in New England, no scratches or other marks of ice action have been observed by any of our party, though carefully looked for. I shall examine the crests of the accessible mountains for traces, this fall, if possible. Notwithstanding the cessation of operations by the Telegraph Co., I intend, if I can obtain the necessary permission, and trading goods to buy provisions from the Indians, to remain in the country and carry on the work as long as my funds will allow. I shall devote to this purpose the savings of my salary as assistant Surgeon for the last two years, about $600, and endeavor to fulfil my pledge of carrying out the work left almost untouched at Mr. Kennicott's death.

Note on the Physical Geography of the Andes of Quito; by JAMES ORTON. (Letter to J. D. DANA, dated Quito, Ecuador, Oct. 12, 1867.)

Knowing your interest on every fact bearing on Physical Geography, I send you a line from the Andes, preparatory to something more elaborate on my return. The first and most important problem which you suggested previous to my departure, was the slope of the volcanic cones. This interesting question I have ever kept in view in my travels up and down this valley; but

I have time to make only some general remarks. Humboldt's sketch of Catopaxi is manifestly overdrawn. And yet his mistake is very natural, for the angle of a lofty symmetrical cone like that of Cotopaxi is very deceptive. I never knew an attempt to draw by the eye a volcanic peak without the error of making it to steep. One of my party made Humboldt's mistake in pencilling Cotopaxi. Upon assuring him that he had made the angle to acute, the artist at once replied that his drawing would not look like Cotopaxi, were he to give the slope less than 40°. Farrond's distant photographic view of Cotopaxi (I have not seen his near view), is probably correct; yet it does not look like Cotopaxi. It does not give as just a view of the *appearance* of the volcano as Humboldt's. It should be borne in mind that even a photograph of a volcano may distort nature. A photographer may incline his camera upward in order to include the peak; but in so doing he will increase the angle of the slope. We cannot depend, therefore, upon a photograph, unless we are certain that the camera was perfectly horizontal. All the views of Cotopaxi I have seen are from the west, giving the north and south slopes. I have found that by means of level, that the slope of the *west* side is 35°; while the west slope of Tunguragua is 40°. The last great eruptions of these volcanoes occurred within six years of each other,—Cotopaxi throwing out ashes and pumice chiefly; Tunguragua covering its sides with the fragments of a tough, black rock having a slight conchoidal fracture; yet the angle is very nearly the same. Cotopaxi must divide the palm of beauty with Tunguragua, which is equally symmetrical, but not being so isolated is not so striking. Tunguragua has on its north side a stream of broken lava similar to those on the flank of Antisana. Cotopaxi is the great pumice-producing volcano; I observed none around Tunguragua. On Antisana alone I observed laminated obsidian. The altitude of Carguirazo is given, on whose authority I know not, as 15,673 ft. But this is a plain error. For the snow-limit in Ecuador is 15,790 ft.; yet Carguirazo is as snow-clad as Cotopaxi. My theodolite was out of order, and I could not ascertain its true height.

As to the porphyry of the Andes, it has been said that much of it is a porphyry conglomerate. My observations do not verify this statement. It is true I have met with many specimens of pseudo-porphry; but the great mass of porphyritic rock is a true porphyry, having a homogeneous base; the strongest glass I can command does not reveal any signs of conglomeration. I will say, however, with Humboldt, that the scarcity of quartz is quite remarkable. I have noticed but one earthquake and that seemed to fulfill the law—passing at right angles to the great axis of elevation. The great earthquake of 1797, which destroyed old Riobamba, also obeyed the law, leaving its track from Tunguragua through Pelites and Guano to old Riobamba. There is, however, just south of Tunguragua, a long series of undulations of the earth's surface, very uniformly 30 feet apart. If an earthquake produced them, as some think, it moved parallel to the Cordilleras.

It has been stated that the experiments of Wisse with the thermo-barometer prove the accuracy of Regnault's tables,—the differences between the barometric pressures given by Regnault and those found by Wisse never exceeding a few tenths of a millimeter. I have also been trying the same experiments with Green's standard barometer and the boiling apparatus side by side from the sea leavel up to 15,705 ft., and I find a greater conformity at low altitudes than at high elevations. Thus, the mean barometer at Guayaquil is 30·005; the boiling point, 211°·95; the mean barometer at Quito is 21·600; the boiling point, 195°·8; on the top of Pichincha, the barometer stood at 17·074 and water boiled at 184°·5.

I have been making extensive excavations in a ravine near Riobamba, and have taken out over a hundred fossil bones,—among them the femur of a Mastodon 40 inches long, and the skull of a horse. They were evidently washed down from another place, as we seldom find together any two anatomically connected, and many of the bones imbedded are broken. But these relics are interesting as showing the inhabitants of the high valley of Quito in pre-historic times.

Rocky Mountain Coal beds; by Dr. F. V. Hayden. (From a letter to J. D. Dana, dated Cheyenne City, Dakota Ty., Oct. 31st, 1867.)

My investigations during the past summer convinced me that there is no probability that any workable beds of coal will ever be found within the limits of the state of Nebraska. The future prosperity of that state appearing to be so dependent on the discovery of beds of coal within accessible distance, that I turned my attention westward to Colorado and Dakota. I first made an examination of the lignite formations across the first range of the Rocky Mountains, on the Laramie plains, and there I found an excellent quality of Lignite in beds from 5 to 11 feet thick. Rock Creek, a branch of the Medicine Bow river, forms very nearly the eastern limit of this interior basin, and it extends westward nearly to Great Salt Lake. I have estimated the area occupied by these lignite beds at 5,000 square miles. The Union Pacific railroad passes directly through them, and by next season they can be brought into the market. I found a number of impressions of deciduous leaves in this formation, among them, a *Platanus*, and a *Populus* plainly identical in species with those obtained on the Upper Missouri. I then visited the coal beds in Colorado. Passing over the Laramie range of mountains, by the overland stage route, the first coal mines opened are at South Boulder Creek. These mines are called the Marshall mines, and are probably, the most valuable in the west. By means of the dip of the strata we find here exposed the finest section I have seen. Eleven beds of lignite, from 5 to 13 feet in thickness, are revealed, making at least 30 to 50 feet of solid lignite. Dr. Torrey made an analysis of this lignite.

Water in a state of combination or its elements,	12·00
Volatile matter expelled at a red heat in the form of inflammable gases and vapors,	26·00
Fixed carbon,	59·20
Ash of a reddish color or sometimes gray,	2·80
	100·00

All the lignites of the west, are non-bituminous, but in a furnace or stove, burn with a bright red flame, give out a good degree of heat, and, for all domestic purposes, will rank next to the anthracite coals of Pennsylvania. These lignite beds occur all along the foot of the mountains, from Pole creek far south into New Mexico. I have estimated the area occupied by these lignite beds north of the Arkansas and south of Pole creek, to be 5,000 square miles. Very soon the two great railroads, U. P. R. R., and the P. R. R. E. D., will pass directly though these great coal fields, and then they will prove as important to this almost treeless west, as the coal fields of Pennsylvania are to the east. The organic remains show very clearly that all of these western lignite deposits are of Tertiary age, and in an article on the lignite deposits of the west which I hope to prepare for the March number of this Journal, I shall be able to show that the lignite beds of the Laramie Plains, as well as those of Colorado, are parts of the same great basin so largely developed on the Upper Missouri, separated only by the erosion during the elevation of the Rocky mountains, or concealed by the deposition of the White river Tertiary beds. When this great lignite basin has been thoroughly explored, it will be found to be one of the most extensive and interesting deposits on the globe. All the facts which I have obtained during this trip, only confirm the statements which I made in an article published in the Proceedings of the American Philosophical Society, last winter, that the lignites of Colorado and those in the Naton mountains are only the southern extension of those so finely shown on the Upper Missouri.

II.—*Editorial Note.*

Prof. G. Hinrichs, now of Iowa, is circulating, in connection with a resumé in French of a memoir of his, entitled Atom Mechanics, a charge of plagiarism against the writer—and plagiarism from an article communicated for this Journal and refused publication.

The crime is so abhorrent to me, and so utterly at variance with all my practice in life, as I believe my writings testify, that I am almost irresistibly impelled to use in the denial only one short word. But it bears on my editorial relations, and I therefore feel it a duty to state the facts in the case.

The paper referred to was sent to this Journal early in March, when I was too unwell even to look at it. Since December I had been compelled to suspend all head-work, and even my college duties of an hour a day, and I was but just beginning to regain my strength. I had recently resumed the preparation of the new edition of my Mineralogy, but only through an assistant, Professor Barker, and was able barely to give the occasional advice required. The paper of Prof. Hinrichs, on its reception, was put unopened into Prof. Barker's hands for perusal and a report to me of its contents. It was the only mode of editorial reading that I was capable of giving it. In his report, which I regarded as furnishing me a good idea of the scope and character of the article, there was not the slightest allusion to the idea brought out in my paper, or any thing bearing that way. At my request, Prof. Barker, aware of my views, went over it a second time, and added to his former report the further positive statement that he found no views similar to mine in the article. It was filled with other discussions, and seemed, in the main, to consist of baseless speculations. Unwilling to act editorially on my own judgment of the article thus obtained, the paper was sent, without accompanying comment, to Dr. Gibbs of Cambridge, our associate editor; and on receiving his advice to return it to the author, it was returned. Later, another paper of the same nature came from Prof. Hinrichs, accompanied with an angry and peremptory note; it was almost immediately returned to the author after only a very partial perusal. We had already had in the Journal a specimen of Mr. Hinrichs's speculations on atoms, at page 365 of volume xlii, which, from the first reading, had seemed to me fanciful and unintelligible, and as acceptable in that place only as the thoughts of a man of unquestioned learning.

The views which I advanced in my paper occurred to me while attempting to write out the formulas of the mineral silicates on the basis of SiO^2 instead of SiO^3. This changed the formulas for the Unisilicates from $\dot{R}^3\dddot{Si}$ to $\dot{R}^2\ddot{Si}$; and for the Bisilicates from $\dot{R}^3\dddot{Si}^2$ to $\dot{R}\ddot{Si}$. It brought, literally before my eyes, the fact of the connection of Tetragonal forms with 4 of oxygen (as in Unisilicates), and not with 3 of oxygen as in Bisilicates; and the view was afterward elaborated, and published in the July number of this Journal, without a suspicion that Prof. Hinrichs had ever held, or thought of, such a kind of relation, or had made any special use of the numbers 3 and 4 in connection with atoms.

Early in August came by letter Mr. Hinrichs's first charge of plagiarism. I promptly denied it in a friendly note, for, until the return of his article, our relations had been of the most friendly kind. Knowing of no ground for the charge in the papers returned, and observing that I was suspected also of having used a copy of his Atom Mechanics (in German), sent to the College Library, (received there July 2d, some time *after* my paper was wholly printed off), I at once referred to the memoir: and, on examination, I found there, besides various speculations, embracing the wide range of physics and chemistry, some degree of coincidence in one part with my own idea, although much involved with other hypothetical views. I wrote him the next day that I should take pleasure in giving him full credit for priority (the publication of his memoir antedating that of our July number over a fortnight) in any points in which, on further examination I should find he had anticipated me; that I should make such acknowledgment willingly, caring less who brings out new ideas, than for the ideas brought out; and in the September number, on page 263, a note is appended to my article admitting the coincidence and priority here referred to, with a promise of a review of the memoir at another time. Until August I had not seen the "Atom Mechanics."

Before the September No. of the Journal was issued, Prof. Hinrichs gave an abstract of a portion of his Atom Mechanics in the Journal of Mining published in New York City; and in the course of his concluding "historical remarks" (Sept. 7) he took occasion to make public his charge of plagiarism. The charge was followed, in the same Journal, by a brief statement of the facts by me, showing that the charge was utterly and completely without foundation.

He now reiterates the charge; and I make here my final denial. His first suspicion was perhaps natural. His reiteration, after the statements and explanations which have been made, with the further untrue statement that my former denial was not full and complete, shows a disordered state of mind and temper.

Prof. Hinrichs includes, in his last charge, my September article. The prominent peculiarity of the paper (apart from some of its mineralogical details) is the use of Greek letters in the symbols of the different oxyds (deutoxyds and tritoxyds as well as protoxyds and sesquioxyds) reduced alike to the protoxyd type; and the writing out of the formulas by this means systematically on a unit scale. The idea of reducing the oxyds to the protoxyd type is old, as I have recognized; yet it is ordinarily restricted by chemists who adopt the view to protoxyds and sesquioxyds. The general formulas, on the new system, of the Unisilicates, Bisilicates and Subsilicates, are those of Odling, Wurtz, etc. The recognition of the grand types of Unisilicates, Bisilicates and Subsilicates is the fundamental idea in the classification of the Silicates in my Mineralogy of 1854 (last edition), and is there brought out more fully than by any previous author. Moreover, in this same volume, the view that the oxyds, from protoxyd to tritoxyd, are mutually replaceable, on the principle that replacing power equals combining power (an idea which I had deduced long before from the writings of Gerhardt and Laurent), is adopted throughout.

These important points do not appear to be embraced in the charge, but only the trivial one of placing, in the formulas, the symbol of the uniting oxygen, O, *between* the symbols of the acidic and basic elements, instead of after a bracket as is usually done, which position he regards of theoretical importance. I was not aware that Prof. Hinrichs had thus placed the O, or that there was any theoretical reason for preferring this method; and *his* reason, which I have recently learned, is based on a principle that is directly opposed to my published views. I adopted the plan simply because the formulas thus arranged took up less space on the page, and were more easily compared in a table.

Now for some facts of *another kind.* I touch on only half a dozen points out of many in the memoir of Prof. Hinrichs.

In the "Atom Mechanics" there are the following paragraphs:

> § 253. *Chrysoberyl* has its prism 119° 46′, or 14′ less than 120°; the other angle is 120° 7′, instead of 120°. The vertical axis is given $a = ·81$ (Dana); but the form admits of $a' = \frac{3}{2}a = 1·21$ quite as well. In this case, however, 1·21 is only 0·01 smaller than $1·22 = \sqrt{\frac{3}{2}}$. So that chrysoberyl must be referred to a fundamental form differing very little from the tesseral form in a rhombohedral position. With this view the formula $\dot{\mathrm{B}}\mathrm{e}\,\overset{\dots}{\bar{\mathrm{A}}}\mathrm{l}$, also coincides; by which it is placed with the Spinel group. *Dana,* it is true, gives $\bar{\mathrm{B}}\mathrm{e}\,\overset{\dots}{\bar{\mathrm{A}}}\mathrm{l}$, which allies it to corundum; but in the latter $a = 1·361$, which is very different.
>
> § 254. We could cite very many such forms; our space however will not permit it. The two exceptions above given are sufficient to show that whoever bases a classification upon crystal-systems, builds a purely artificial edifice, which must give way before the first earnest investigation. One might quite as well classify asses according to the lengths of their caudal appendages expressed in centimeters, as minerals by their systems of crystallization. Brookite, anatase, rutile, are essentially alike; in *Dana's* system, these identically similar substances are placed in three different groups. Thus it is in innumerable cases.

Prof. Hinrichs here attributes to me, in the first place, views I do not hold, and, secondly, presents, as his own, ideas which were published by me in the last edition of my Mineralogy, and the volumes of this Journal for 1854.

On pages 196 to 205 of the Mineralogy, after general observations on Isomorphism (or homœomorphism as I there term the principle), in which I dwell on the fact that the fundamental forms of the crystals of species, as adopted by crystallographers, often are not those exhibiting the true homologies of the forms, I give a series of tables, intended to illustrate the close relations of all crystalline forms to the tesseral or isometric (monometric) system, and to present the true homologies as deduced therefrom.

In these pages I do not use the forcible and elegant comparison to asses tails; but have the idea in this form: "Homœomorphism [meaning ordinary isomorphism], as Laurent has observed, is not confined to forms of the same system alone."

I afterward show that *rutile* and *anatase,* although made to differ widely in angle in the ordinary statements of the crystalline forms by authors, are actually almost identical in fundamental form. On page 197, there is a table in which the various Tetragonal (or Dimetric) minerals are arranged in Sections, with their angles, these Sections being based on the usually accepted forms.

Tin is in section I; *rutile*, cassiterite, etc., in section II; scapolite, etc., in section III; *anatase*, etc., in section IV. I then say, on page 196, that these sections I, II, III, IV, constitute a single group; and that in this group "*the basal angle of the fundamental octahedron is near* 90°;" and this group, which includes *Anatase*, I name the *Rutile group*. This is in direct opposition to the statement of my views by Prof. Hinrichs.

Brookite (of the orthorhombic system) I do not compare directly with rutile. But I illustrate on pages 200 and 202 the near relations of its prismatic form to the *tesseral* system. I have not regarded divergences, like that of brookite, as so little important as Prof. Hinrichs does; and I do not yet see reason to change my opinion on the subject.

With regard to *Chrysoberyl*, I point out similar relations to the tesseral or isometric system. A table on page 201 contains orthorhombic species in which the vertical prism is near 120°. In this table, and the same section of it, occur *chrysoberyl*, *aragonite*, *discrasite*, and a number of other species. In the remarks which follow on the tesseral relations of the forms, I observe that in this section, *the brachydome is near* 109° 28′, *the angle of the octahedron.* Moreover, in order to bring out this relation, I have taken $\frac{3}{2}a = a$; and the symbols $\frac{3}{2}$-$\breve{i}$ and $\frac{3}{2}$-$\bar{i}$ stand before the values of the angles of the domes of chrysoberyl in the table. The query naturally arises whether Prof. Hinrichs had not seen $\frac{3}{2}$ in Dana's Mineralogy, and the *tesseral* relation explained to his hand.

Prof. Hinrichs is wrong in making the formula of chrysoberyl (glucina being a protoxyd) $\dot{\mathrm{B}}\mathrm{e}\ \bar{\mathrm{A}}\mathrm{l}$, or that of the Spinel group. It is $\dot{\mathrm{B}}\mathrm{e}^{8}\bar{\mathrm{A}}\mathrm{l}$.

In § 252 of the "Atom Mechanics," Prof. Hinrichs has the following sentence:

> *Discrasite* or *antimonial silver*, has according to Dana, the vertical prism 119° 59′; deviating therefore only about 1 *minute* from the hexagonal. And this, notwithstanding the admission of many degrees of variation in the hexagonal system (in relation to the vertical axis) without destroying the isomorphism! A deviation in another direction, however, even so slight as this, is followed by complete exclusion!

The point here is this: that I refer discrasite to the orthorhombic rather than *hexagonal* system, when there is a deviation of only 1′ from 120°. I have done this because the form *is* orthorhombic, not only in its angle, but also in the whole symmetry of the crystals. It is geometrically orthorhombic, as distinctly so as any other orthorhombic species. The question of relation to the hexagonal system is not one to be considered in such a reference. Further, not only has "Dana" done this, but so have all other authors who have written on the subject, whatever their views as to any isomorphous relations with the hexagonal system.

Prof. Hinrichs refers for the angles of species constantly, and almost exclusively, to my work (edition of 1854), and in this he gives me boundless credit undeserved, and is quite unfair to the various authors who are the real sources of the information. But when he proceeds to criticize the facts, or the mode of presenting them, or to show triumph over his better figures and methods, there is some unfairness to "Dana." It is not altogether pleasant to have to bear alone what might properly be administered equally to such men as MOHS, HAIDINGER, NAUMANN, ROSE, VON KOBELL, HAUSMANN, BREITHAUPT, BROOKE, PHILLIPS, MILLER, DESCLOIZEAUX, and many others.

Prof. Hinrichs says in § 251:

Finally, it is remarkable how almost entirely the RCl and $RO\,R^2O^3$ species belong to the tesseral system; in spite of the fact that *Dana's* antiquated formulas represent the first of these, $PbCl_2$, as $PbCl$.

If we examine the hexagonal forms more closely in relation to their axes we find

Axis	·7	·8	·9	1·0	1·1	1·2	1·3	1·4	1·5	1·6	1·7
No. of species,	5	12	0	0	4	0	7	1	1	1	

so that the 31 species (*all* the hexagonal minerals, except the silicates and hydrates) represented are very unequally distributed. They form three groups; that *of Apatite*, *of Calcite*, and *of the Elements.*

And in § 329:

"The normal form of the deltoid (in the Calcite group) is a rhombohedron of 104° 29′, or an octahedron with the axes $x:y:z=\sqrt{3}:1:\sqrt{3}$."

The sentence about "antiquated formulas" is a fair exhibition of the spirit of the writer. I pass it without remark, except to say that the formula which he substitutes is, in chemistry, *of later origin than my book.*

In the Mineralogy, on page 198, I have the Hexagonal species arranged, with their angles, in a table. The table is divided into Sections like the others, according to the ordinary statements of these angles. One section of it, the fifth, is *that of Calcite*, another, the fourth, is *that of the Elements;* and in one of the other three occurs *Apatite.* Of these three, I state that the third is related to the *fourth*, the rhombohedral angle being equally near 90° and but a little above instead of below 90°; and that the second, which contains *apatite*, differs from the first only by the simple ratio of $1:\frac{2}{3}$, adding that "the second becomes united to the first if we take the plane $\frac{2}{3}$ as 1."

I further state that "*the basal angle of pyramid* 1 *in the Calcite section is near* 90°; *and hence R : R in Calcite, etc., is near* 105°," making this tesseral feature the direct origin of the angle 105°, as done by Prof. Hinrichs. Calculating from the angle 90°, we obtain the angle 104° 29′, which he introduces into his statement of the fact.

I might go on with cases of the kind, but the above are sufficient. It is already plain that Prof. Hinrichs had studied Dana's Mineralogy before writing his Atom Mechanics, and to some advantage. His abundant references to it all show that he used the work much, and gathered ideas as well as the values of angles. This is in accord, moreover, with his acknowledgments, in the course of our former correspondence, of his great interest in my views on crystals. His "discovery" (I should call it *invention*) of "pantogen," took place, as he states, in 1855; and as its subsequent development was slow, according to his own statement, its ideas may have been largely of much later date; while the Mineralogy and the volumes of this Journal referred to, were published a year before the inception, in 1854. Prof. Hinrichs is welcome to what he has taken, and I wish him all the joy over it which he has hitherto manifested. I should not have brought up these matters, had it not been made a necessity by his charge. I believe him of honest intentions, which is more than he is now willing to say of me; and but for the *return* of his paper, the "Atom Mechanics" would have been written, I cannot doubt, in a better spirit. I sincerely hope that he may soon emerge from his cloud of suspicion, and again take a hand that is still disposed to be friendly. JAMES D. DANA.

Statement of Professor Barker.

During the spring of 1867, I assisted Professor Dana in preparing the manuscript of the new edition of his Mineralogy for the press. His health at that time was such as to forbid any mental work, save that required to direct my labors. When Mr. Hinrichs's manuscript came to the Journal of Science, it was, consequently, placed in my hands for examination. I read it carefully and returned it to Prof. Dana, stating that in my opinion, the views it contained were purely speculative; that the assumptions made in it were not proved, and were not in accordance with facts.

A short time afterward, Professor Dana explained to me his views on the connection between the number of atoms of oxygen in a compound, and its crystalline form; and also his idea that the polarity might be produced by an accumulation of the negative atoms at one end of the molecule, and the positive at the opposite.

These views struck me at the time as entirely new; and I am confident that they originated solely with Prof. Dana. He did not read Mr. H.'s manuscript personally, and knew nothing of its contents except what I had told him. As therefore I had assured him that these views were not contained in Mr. H.'s paper, even after a re-examination of it, Prof. Dana could not do otherwise than publish them as original.

A month after the "Atom Mechanics" reached the college library, when for the first time I saw this memoir, I found that the rs 3 and 4, occupied a prominent place in the classification elements, the metalloids, being trigonoids, and the metals, ɔnoids. Moreover, the crystalline form of a salt, as AB_nO ade to depend upon a plane equator, having *n* sides, and A C ertical axis. There is here an apparent approximation to ews of Prof. Dana. But neither these views nor any resem- hem, do I remember to have seen in the original manuscript. ed there, they were so covered up by fanciful analogies as be prominent, and hence made no impression upon my mind. y be regarded as establishing a real coincidence, Prof. Dana not chargeable with plagiarism; the coincidence is rightly ed to "independent action in independent minds." And in ver of truth there is common to both authors, Prof. Dana eady acknowledged Mr. H.'s priority of publication.

GEORGE F. BARKER.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

Vote by J. D. Dana.—In the last volume of this Journal, 401–406, I have pointed out a relation in anhydrous silicates n the proportion of alkalies or perissads among the prot- ases, and the amount of silica. The following table con- he examples thus far observed with the oxygen ratio for the ind silica in each, and in the last column the oxygen ratio of n-alkaline to the alkaline protoxyd bases, that is, of the Ċa, Ḟe, etc., to the Ṅa, L̇i, K̇, etc. The species *of the same group* be compared with one another, and not those of different .

		Bases		Silica	Non-alk.		Alk.
LITE GROUP.—	Chrysolite, etc.	1	:	1	all non-alk.		
	Leucophanite	1	:	1⅔	4½	:	1
ITE GROUP.—	Phènacite, etc.	1	:	1	all non-alk.		
	Meliphanite	1	:	1⅓	6	:	1
E GROUP.—	Epidote	1	:	1	all non-alk.		
	Zoisite	1	:	1	all non-alk.		
	Saussurite	1	:	1⅙	6	:	1
	Jadeite	1	:	2	1	:	2
ROUP.—	Astrophyllite	1	:	1	6	:	1
	Phlogopite	1	:	1	3	:	1
	Biotite	1	:	1	3	:	1
	Lepidomelane	1	:	1	2—1	:	1
	Muscovite	1	:	1½	1	:	2—6
	Lepidolite	1	:	1⅓	1	:	3—12
	Cryophyllite	1	:	2	1	:	2⅓
ITE GROUP.—	Sarcolite	1	:	1	9	:	1
	Meionite	1	:	1	10	:	1
	Paranthite	1	:	1	all non-alk.		
	Wernerite	1	:	1⅓	4	:	1
	Ekebergite	1	:	1⅓	2½	:	1
	Mizzonite	1	:	1⅔			

		Bases		Silica	Non-alk.		Alk.
	Dipyre	1	:	2	1	:	1
	Marialite	1	:	$2\frac{1}{6}$	1	:	2
LEUCITE GROUP.—	Sodalite	1	:	1	all *soda*		
	Leucite	1	:	2	all *potash.*		
FELDSPAR GROUP.—	Anorthite	1	:	1	all non-alk.		
	Labradorite	1	:	$1\frac{1}{2}$	2	:	1
	Hyalophane	1	:	2	$1\frac{1}{3}$	:	1
	Andesine	1	:	2	1	:	1
	Oligocase	1	:	$2\frac{1}{4}$	1	:	2
	Albite	1	:	3	all alk.		
	Orthoclase	1	:	3	all alk.		

The minerals *Jadeite* (of Damour) and *Saussurite*, of the Epidote group, are here added to those before alluded to. Jadeite has the oxygen ratio for $\dot{\mathrm{R}}$ (principally $\dot{\mathrm{N}}\mathrm{a}$), $\dddot{\mathrm{A}}\mathrm{l}$, $\ddot{\mathrm{S}}\mathrm{i}=1:2:6$, and the high specific gravity of 3·33 to 3·35. Dr. T. S. Hunt, in a paper treating of the identity of Saussurite and Zoisite, observes that jadeite has the ratio of dipyre with the sp. gr. of zoisite; and he concludes that it belongs to the Epidote group, and has the same relation to zoisite as dipyre to meionite.

It is here shown that this relation extends also to the *alkalinity* of the species. Moreover it appears probable that Saussurite is intermediate between zoisite and jadeite, like wernerite between meionite and dipyre.

The proportion of alkalies in Cryophyllite is wrongly stated on page 402. Prof. Cooke, in his analysis found almost three-fourths of the iron to be protoxyd; and the ratio of alkaline bases to other protoxyds is therefore 2·18 : 1. It is accordingly an exception to the views advanced, as the proportion of alkalies is less than in lepidolite, though not less than in muscovite. It is to be here noted that cryophyllite is known from only one locality, where it occurs with *altered* zircon. It is possible that like the zircon, it has undergone some alteration, although not showing external evidence of it.

In the formula of topaz, on page 258, of last volume, the ratio of oxygen to fluorine should be 4 : 1 (or $\frac{4}{5}:\frac{1}{5}$).

2. *On the Source of Muscular Force;* by JOHN DOUGLAS, East-India Government Telegraph Department.—The attempts hitherto made to settle the question of the source or sources of muscular energy have consisted in calculating the quantity of muscle, the component nitrogen of which would equal either the nitrogen ingested or excreted during the performance of certain measured external work.

The consideration of the ingesta appears to promise the most reliable results if the nitrogen be reduced in quantity until just sufficient to support the body in health. In considering ingesta, it may be known for certain that all the effective nitrogen is included in the calculation; in considering excreta there is no such certainty. The data furnished by ingesta may be collected over a longer time than those furnished by excreta, the latter being obtained only by continued expenditure of time and labor on the part of the observer and subject or subjects under observation;

at generality so desirable in physiological inquiries is almost, quite, unattainable in the consideration of excreta, whereas, wn below, it is easily attainable in considering ingesta.

only source of the nitrogen of the muscles is the food, it generally admitted that none is absorbed under ordinary istances by the lungs and skin. Observers agree on this although difference of opinion exists as to its evolution by organs.

ppeared to me possible that the natives of India might h a class of persons who habitually ingest the required min- of nitrogenous food, and that the quantity of muscle d under the most favorable suppositions from this might ufficient to supply by its disintegration the internal work ; the difficulties of time, generality, absolute determination reta, a determination of external work might in such a case iminated. After some inquiry amongst the native popu- , I thought it possible that the jail dietary-scales might h the data required, and with many advantages which not be hoped for from inquiry amongst the free population. gh the kindness of Dr. Wilson, in medical charge of the s Penitentiary, I was supplied with the dietary-scales in use t prison, and from this paper I shall select only two instances.

items composing these diet-scales may be divided into two —(1) articles the same quantities of which are served out and (2) articles which are varied in quantity on different n the week. In the Table given below, of articles belong- the first class the actual daily quantities, of those belonging second the average daily quantities, calculated for one week, ven:—

Nitrogenous Food served out to classes of Prisoners in the Madras Penitentiary.

Articles.	Proportion of proteine compounds.	Brahmins.		Malays and Chinese.	
		Daily quantities of food.	Quantities of proteine compounds.	Daily quantities of food.	Quantities of proteine compounds.
		ozs.	ozs.	ozs.	ozs.
	·08	25·000	2·000	26·000	2·080
	·24	2·857	0·686	0·857	0·206
n	·24	----	----	1·889	0·453
	·20	----	----	1·250	0·250
ind	·04	·500	0·020	0·500	0·020
powder	·04	·500	0·020	0·500	0·020
ables	·03	2·571	0·077	2·571	0·077
s	·03	·500	0·015	0·500	0·015
	·03	·029	·001	0·029	0·001
r-milk or tyre (curd-milk)	·07	10·000	0·700	4·286	0·300
proteine compounds.	----	----	3·519	----	3·422
e imprisonment prisoners, and prisoners for l receive one-fifth less			·704	----	·684
		A	2·815	B	2·738

Assuming all the proteine compounds ingested in these cases to be assimilated, and transformed without waste into an equal weight of muscle, 1 grm. of muscle, giving by its disintegration 1848 meterkilogs. of force (Frankland, Phil. Mag., xxxii, 188 [and this Jour., xlii, 407]), the muscle so formed would in each case give—

A.	B.
Meterkilogs.	Meterkilogs.
146,842	143,335

the latter quantity being less by 16,677 meterkilogs, than the daily expenditure in the work of the circulation and respiration, given by Helmholtz and Fick at 160,012 meterkilogs. (*Idem*).

It might be objected that the prisoners live in a higher temperature than the subjects, observation on whose circulation and respiration furnished the above data; but the quantity of clothing worn is so small, and loss of heat by evaporation and radiation consequently is so much greater in the one case than it was (probably) in the other, that the effect of this difference of temperature is probably neutralized at least by these attendant conditions. But if it be admitted that the difference of 10 per cent can be so accounted for, the source of external work must be looked for elsewhere than in the disintegration of muscular tissue, as in this case the whole of the muscle formed from the food would be required to furnish the internal work alone. The proportions of proteine compounds given in the Table are above the truth, in many cases considerably so; and the result is, the energy obtained must be considered an exaggeration.—*Phil. Mag.*, Oct. 1867.

4. *On the cost of the Electric Light;* by Moses G. Farmer.—The time appears to be near at hand when the electric light will be used for a variety of purposes. Is is worth our while to inquire as to its cost. The expense and inconvenience attendant upon the production of electricity upon a large scale has hitherto been an obstacle in the way of using the electric light, except for lecture rooms and a few other purposes. But the recent improvements in the construction of magneto-electric machines and thermo-electric batteries have put in our power to command the services of this beautiful illuminating agent on any desirable scale of magnitude.

In order to examine the question of cost intelligently, let us refer both electrical and illuminating effects to the common measure of power, viz: the foot-pound per minute. The experiments of Mr. Julius Thomson, of Copenhagen, have shown that the power to maintain the light to that of a standard candle for one minute is equal to the raising of a weight not exceeding thirteen pounds, one foot high in that time. I have arrived at a similar result from a reduction of recorded experiments made by Müller, Ritchie, myself, and others. I am satisfied that, where an electric light of not less than eight hundred to one thousand candles is produced, under proper management, the power required will not greatly exceed 15 foot-pounds per minute per candle. For smaller amounts of light the power required will be greater.

Now let us inquire what amount of electricity is the equivalent of, or is represented by 15 foot-pounds per minute. If 100 feet of No. 18 pure copper wire be coiled into a helix and immersed in a pound of water, and if the ends of this wire be connected to the poles of one cell of the Grove battery (pint cup size as used in telegraphing), the temperature of the water will begin to rise at the rate of 1° F. in 9½ minutes, or 0·105° per minute. Now if the temperature of one pound of water be raised one degree (Fah.) per minute, this effect will be the thermal equivalent of 772 pounds raised one foot high in space per minute; the heating effect then, of our Grove cell upon the water is the equivalent of $0·105 \times 772 = 81$ (call it 80) foot-pounds per minute.

It is well known that a galvanic battery will perform its maximum work when the external resistance which it encounters is equal to the internal resistance of the battery. I have found the internal resistance of the pint cup Grove cell to be equal, on the average, to that of 100 feet of pure copper wire, No. 18 size. Hence the maximum external effect of the ordinary Grove cell may be set down as the equivalent of 80 foot-pounds per minute, equal to the production of $80 \div 15 = 5\frac{1}{3}$ candle lights. I would not be understood as saying that this amount of light can be produced by a single Grove cell, but that 1,000 cells, if properly arranged, would be capable of evolving somewhat more than 5,000 candle lights from a single lamp.

With sulphuric acid costing 2½ cents, nitric acid 10 cents, zinc 8 cents, and mercury 50 cents per pound, the cost of running 1,000 Grove cells one hour, while doing their maximum work, would be $27.65. This would give for 5,000 candles a cost of about 5½ mills per hour per candle.

The cost of gas light per candle per hour would be about one mill, if gas costs $3.25 per thousand cubic feet, and if one cubic foot per hour gives the light of three candles.

With the Smee battery, carefully managed, the cost of 5,000 candle lights would be about the same as with gas.

Let us now look at the cost of electricity as developed by the magneto-electric machine. The power expended on the machine is consumed in friction, in heating the wires, magnets, etc. On a well built machine which I examined in 1861, 1,100 foot-pounds per minute were required to keep the machine in motion when the circuit was open, and the machine doing no work. But when the circuit was closed 3,200 foot-pounds per minute were required to maintain the same velocity of rotation; nearly all this excess of power (viz., 2,100 foot-pounds) was measured as electricity, about two-thirds (say 1,300 foot-pounds) being expended internally, heating the coils and magnets, etc., and the balance, 800 foot-pounds, measured as external useful effect. Had the external resistance been larger, a greater proportion of the expended power would have appeared as useful effect. Suppose, however, that only 800 foot-pounds per minute could be utilized by this machine and used for illuminating purposes. This would be the equivalent of $800 \div 15 = 53{\cdot}33$ candles, and the total power required (including friction, etc.), would be $3,200 \div 53{\cdot}33 = 60$, about sixty foot-pounds per minute per candle.

In the vicinity of Boston, power is furnished, per horse power, at the rate of $180 per year of 313 days of ten hours each, or at the rate of $\frac{\$180}{313\times10} = 0{\cdot}0575$ (5¾ cents) per hour. If only one-fourth of this power could be utilized as light $\frac{33,000}{4\times15} = 550$ candles would be the equivalent of one horse power, and would cost $\$0{\cdot}0575 \div 550 = \$0.0001046$, about one-tenth of a mill per hour per candle, being about one-tenth the cost of gas light.

Let us for a moment take another view of the matter. The average hourly consumption of coal by a good steam engine may be set down at four pounds per hour per horse-power, $=(33,000\times60)\div4=495,000$ foot-pounds from one pound of coal. Utilizing as electricity, and thence light, one-fourth part of this we get $495,000\div4=123,750$ foot-pounds, or as light, $\frac{123,750}{15\times60}=137.5$ hour candle lights from one pound of coal, through the agency of steam engine and the magneto-electric machine.

With the thermo-electric battery I have been able to develop 130,000 foot-pounds of electricity from one pound of coal$=\frac{130,000}{15\times60}$ $=144{\cdot}4=$to about 144 candle lights.

There is still another point of view worthy our attention. Common gas coal will yield about ten thousand cubic feet of gas per ton. This, at three hour candle lights per cubic foot, would give $(3\times10,000)\div2,000=15$ hour candle-lights per pound of coal. About twenty-five cubic feet of illuminating gas weigh one pound. Hence one pound of gas, after it is made from the coal, will yield a light equal to that of a candle for seventy-five hours. One pound of pure carbon, wholly burned to carbonic acid gas, yields 14,500 units of heat, equal to $772\times14,500=$ 11,200,000, or 11¼ millions of foot-pounds of work: Hence, were the total energy of one pound of pure carbon converted into light, it would be equivalent to one candle light for the time of

$\frac{11,200,000}{15\times365\times24\times60}=1\frac{5}{12}$; or one year and five months.

To recapitulate: the gas made from one pound of coal would yield a candle light for fifteen hours; one pound of the gas would yield a light equal to one candle for seventy-five hours; but could all the energy in a pound of carbon be converted into light, it would be equivalent to the burning of a candle for 12,410 hours.

Thus it will appear that by our ordinary methods of gas lighting we utilize much less than one per cent of the energy stored in the coal. I think we may reasonably expect that electricity, as developed by the thermo-electric battery, the magneto-electric machine, or some still more efficient apparatus, will help us in some way to bridge the chasm between fifteen and twelve thousand hour candle lights from a pound of coal.—*Scientific American.*

3. *On a new form of Dynamo-magnetic Machine;* by William Ladd, F.R.A.S.—It is now thirty-six years since Faraday first published his celebrated 'Researches in Electricity and Magnetism;' the foundation then laid has been receiving additional strength as the superstructure has progressed. Faraday has gone to his rest, but the name he always tried to hide behind his philosophy will shine brighter and brighter, until the top stone is raised in future ages. The machine I am about to describe is a part of that superstructure. The repeated application to me for a machine that would give a sufficient light for the purposes of lecture demonstration and would dispense with the galvanic battery has induced me to give considerable attention to the subject, and I must leave you to judge how far this machine meets, not only that requirement, but also that of lighthouse illumination.

Perhaps the most powerful magneto-electric machine was that constructed by Mr. Wilde, the electro-magnet receiving its charge from sixteen permanent steel magnets, but Siemens and Wheatstone have shown that the residual magnetism left in soft iron, after being under the influence of a battery, or permanent steel magnets, can be augmented from the currents generated by itself, by merely applying dynamic force to the revolving armature, containing a coil of copper wire, the terminals of which are connected with the wire surrounding the electro-magnet; and although great effects were produced *in* the electro-magnet, the current itself could only be made available by its partial or total disruption—in the former case diminishing the power of electro-magnet, and in the latter reducing it to its normal condition. But in the machine I have constructed, the power of the electro-magnet is kept up, whilst a separate current, to be applied to any useful purpose, can be drawn off by means of an independent arrangement.

It consists chiefly of two plates of iron; to both ends of each plate is fixed a portion of a hollow cylinder; these plates are then placed a certain distance apart, and insulated from each other in such a manner that the cylindrical pieces will form two hollow circular passages; into these spaces two armatures (known as Siemens' armatures) are placed. The plates are surrounded by a quantity of stout copper wire, connected together, the two terminals of which are brought into connection with the commutator of the smaller armature, so that each change of polarity in the armature will augment the magnetism. When the machine is first made it is only requisite to pass a current from a small cell of Smee's, or any other element, for an instant, to give the iron a polarity; it will then retain a sufficient amount of magnetism for all future work.

If the armature in connection with the electro-magnet is made to rotate, there will be a very feeble current generated in it; this passing round the electro-magnet, will increase its power with every additional impulse. It will thus be seen that the only limit to the power of the machine is the rapidity with which the armature is made to rotate, which is entirely dependent on the amount of dynamic force employed. But the great improvement in this machine is the introduction of the second armature, which, although it takes off very powerful currents generated in its wire by the increased magnetism, does not at all interfere with the primary current of the electro-magnet.

The machine now at the Paris Exhibition measures about 24 in. in length, 12 in. in width, and stands 7 in. high; but this being imperfectly constructed as to its proportions, the results obtained are, no doubt, much less than they would be with a properly constructed machine. Still, I found it would keep 50 in. of platinum wire, ·01 in. in diameter, incandescent, and when a small voltameter was placed in circuit with the second armature it would give off 250 cubic centimeters of gas per minute, and in connection with an electric regulator would give a light equal to about thirty-five Grove's or Bunsen's elements, the driving power expended being less than one horse.

I have now to describe a machine on the same principle as that just noticed, but which, instead of having two independent armatures running in separate grooves, has two armatures fixed end to end, so as to appear like one continuous armature, but so placed with reference to each other that their magnetic axes shall be at right angles. By this arrangement there is only one opening required for the armature, enabling us to take full advantage of the horse-shoe form of electro-magnet. The shoes of the electro-magnet and armatures are so proportioned to each other that there is an actual break in the magnetic circuit with reference to each armature alternately, but by their disposition at right angles there never is an actual break in the complete magnetic circuit, but simply a shifting of the principal portion of the magnetic force from one armature to the other at the precise moment required to produce the best effect. The mechanical advantages obtained by this disposition of parts must be at once obvious, as one pair of bearings and set of driving gear is dispensed with, and from the fixing of the two armatures together the currents are made to flow perfectly isochronously. It may be found of advantage to vary the angle of position of the armatures with reference to each other, according to the speed at which they are driven, so that the current given off by the exciting armature may at the precise moment exert its full effect upon the electro-magnet, and thus produce the best effect in the second armature.—*The Laboratory*, i, 407, Sept. 14, 1867.

4. *On a Real Image Stereoscope;* by J. Clerk Maxwell, F.R.S.—In all stereoscopes there is an optical arrangement by which the right eye sees an image of one picture, and the left eye that of another. These images ought to be apparently in the same place and at the distance of most distinct vision. In ordinary stereoscopes these images are virtual, and the observer has to place

his two eyes near two apertures, and he sees the united images, as it were, behind the optical apparatus.

In the stereoscope which I have had made by Messrs. Elliott Brothers the observer stands at a short distance from the apparatus, and looks with both eyes at a large lens, and the image appears as a real object close to the lens.

The stereoscope consists of a board about two feet long, on which is placed—1. A vertical frame to hold the pair of pictures, which may be an ordinary stereoscopic slide turned upside down. 2. A sliding piece near the middle of the board, containing two lenses of 6 in. focal length, placed side by side, with their centers about 1 inch and a quarter apart. 3. A frame containing a large lens of about 8 in. focal length and 3 in. diameter.

The observer stands with his eyes about two feet from the large lens. With his right eye he sees the real image of the left hand picture formed by the left hand lens in the air close to the large lens; and with the left eye he sees the real image of the other picture formed by the other lens in the same place. The united images look like a real object in the air close to the large lens. This image may be magnified or diminished at pleasure, by sliding the piece containing the two lenses nearer to or farther from the picture.—*The Laboratory*, i, 408, Sept. 14, 1867.

[We regret to announce that this valuable little journal is compelled to suspend publication, for want of sufficient support. In the twenty-sixth number which completes the first volume, the editor, Mr. John Cargill Brough, after stating the above facts, and alluding to the high scientific character of its original articles (in which we heartily concur), hints that the Laboratory may reappear in another form at the commencement of the next year].

II. MINERALOGY AND GEOLOGY.

1. *Extract from a paper on Borates and other Minerals in Anhydrite and Gypsum of Nova Scotia;* by Prof. How, Windsor, N. S.*—*Silicoborocalcite, a new mineral.*—The mineral exhibits very different degrees of hardness; the hardest specimens are found imbedded in anhydrite, the softest in gypsum; both matrices occurring in the same deposit, at Brookville, about three miles south of Windsor. The hardest mineral is in white, rounded, often egg-shaped nodules, brittle and of nearly even and smooth fracture, which is observed in the broken masses giving almost flat surfaces continuous with those of the matrix; these surfaces are dull. The nodules are generally about the size of filberts or pigeons' eggs; the largest specimen I have, is a fragment of about two inches diameter; they sometimes show when detached, a sub-vitreous luster in the exterior. The mineral is translucent in thin fragments, its powder is seen under the microscope to be transparent and crystalline; the form is possibly rhombic. The greatest hardness is about 3·5; specific gravity, 2·55. Before the blowpipe hard fragments

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* The paper is to appear in the L. E. & D. Phil. Mag.

decrepitate strongly and all fuse readily to a clear colorless bead, the inner flame assuming a green color which is quite deep when the mineral has lain for some time in water. Fragments fuse even in lamp-flame to a colorless blebby glass which when further heated B.B., froths considerably and finally becomes quite clear. The clear bead can be rendered opaque by sudden insertion in, and rapid removal from, the oxydizing flame, probably from formation of bubbles of BO_3 which cannot escape till the bead is further heated, which then becomes clear again and remains so on prolonged heating. These reactions distinguish the mineral from natroborocalcite which colors the flame yellow and gives a clear bead rendered opaque by the method just given, but which on prolonged heating is so reduced in bulk as to leave the wire-loop nearly hollow: the flame becomes decidedly greenish-yellow during this operation. In the former case the silica present is no doubt the cause of the permanent transparency. A minute quantity of either mineral with a drop of dilute HCl gives the BO_3 test most readily. The new borate before ignition gelatinizes perfectly in two or three minutes when its powder is stirred up with cold HCl, after ignition also when left for some time. In the closed tube it decrepitates and gives much water. In the following analyses, the results under I, were from a nodule in anhydrite, those under II, from several fragments, some perfectly dull, others lustrous in parts of the exterior. The absence of soda was proved by testing after removal of BO_3 and SiO_2 by heating with CaF and HSO_4; the BO_3 was estimated by deficiency after gravimetrical determinations of the other constituents in the regular way. Analysis of the air-dry hard mineral gave:

	I.			II.
Water,	11·51	11·60	11·55	11·62
Lime,	28·90		28·90	28·04
Sulphuric acid,		1·03	1·03	0·80
Magnesia,		trace	trace	
Silica,	15·12	15·27	15·19	15·44
Boracic acid,			43·33	44·10
			100·00	100·00

The softest mineral, found in nodules in gypsum, is so unlike the preceding in hardness that at first I thought it might be efflorescent glauber salt, which I had formerly found here in the same matrix. It is like soft chalk or coherent flour. Its flame and blowpipe reactions, except that it does not decrepitate, are those of the harder mineral; it gives the turmeric coloration the same way, and gelatinizes in similar circumstances with equal ease. Analysis of a specimen like flour, air-dried, gave:

	III.
Water,	12·20
Lime,	28·85
Sulphuric acid,	1·86
Magnesia,	trace
Silica,	14·64
Boracic acid,	42·45
	100·00

These results agree so closely with the foregoing from different specimens in a distinct matrix, that there can be no doubt they all relate to a definite mineral whose composition is constant in its varying physical conditions. The percentages correspond remarkably well with those calculated from the formula to which they lead. The results placed below, as found, are those of the analysis III, just given, after deducting the amount of $CaO\,SO_3,\ 2HO$, equal to the SO_3 obtained, which is much greater in this than in the preceding analyses whose numbers are so obviously similar, that deduction in all is quite superfluous.

	Calculated.		Found.
$5HO$ =	45	11·43	11·84
$4CaO$ =	112	28·44	28·69
$2SiO_2$ =	61·62	15·65	15·25
$5BO_3$ =	175·20	44·48	44·22
	393·82	100·00	100·00

Of the various modes in which the constituents of the mineral may be arranged, I prefer the following, and therefore using the notation so far employed in mineralogy, propose the formula,

$$2CaOSiO_2+2(CaO\ 2BO_3,\ HO)+BO_3,\ 3HO,$$

as that of the new mineral, to which I give the name Silicoborocalcite, chosen as companion to that of natroborocalcite, the essential difference in chemical composition between minerals found in the same region, and even in the same matrix occasionally, as will be mentioned, being clearly indicated by these terms; the formula of the latter, according to my own results, when rewritten to include some identical grouping, is

$$NaO\ 2BO_3,\ 10HO+2(CaO\ BO_3,\ HO)+BO_3,\ 3HO.$$

For comparison sake, I add the formula of cryptomorphite, the other borate found in gypsum here, also rewritten on the same plan as the preceding,

$$NaO\ 2BO_3,\ 6HO+3(CaO\ 2BO_3,\ HO)+BO_3,\ 3HO.$$

Interesting relations are thus made to appear between these geologically allied minerals. (For original formulas, etc., see this Journal, 1857 and 1861.) The constituents of silicoborocalcite are those of datholite, the only other known hydrated silicated borate of calcium, for which Berzelius gave the formula,

$$CaO\ BO_3+CaO\ 2SiO_2+HO.$$

This expression exhibits proportions very unlike those shown above to exist in the new borate. In datholite, as in all silicated borates, the boracic acid is sometimes held to be basic, (Dana, Min., 4th ed. i, 207 and ii, 335) on this view, including water as basic, the ratio of O in SiO_2 to that in all the constituents is 2 : 3 in silicoborocalcite as 2 : 12, which is so unlike that in any known compound that SiO_2 cannot be the only acid. The formula I have proposed contains 2 of wollastonite, 2 of normal hydrated biborate of calcium, and one of sassolin. While datholite and silicoborocalcite are quantitatively unlike and physically different, on comparing the well crystallized specimens of the former with the nodules of the latter there is a remarkable resemblance between these and the exceptional state in which Whitney formed datholite near Lake Superior, viz., in perfectly white and opaque nodules like the finest marble or some kinds of Wedgewood ware. (Supplements to Dana's Min., this Journal, May, 1860, and May, 1861). The *crystals* of silicoborocalcite may yet be met with. I found a very small amount of silica, perhaps 2 or 3 tenths per cent, in the anhydrite and gypsum (not earthy) matrices of the new borate.

Selenite is most frequently found with silicoborocalcite and aragonite occasionally. The new borate has been met with in gypsum from Newport, about six miles east of Windsor; it was identical by its blowpipe reaction and qualitative analysis, and its powder gelatinized like that of the Brookville mineral. The Newport mineral appeared the more crystalline.

New localities for Natroborocalcite. Both Brookville and Newport.—At the former an impure earthy gypsum has silicoborocalcite and selenite together in nodules, and natroborocalcite in distinct nodules, sometimes both kinds in a seam of fibrous gypsum. Other purer kinds of white gypsum and selenite also, hold it alone. Anhydrite does not contain it. At Newport, it is in white gypsum. At both places the nodules are harder inside than out; hardness about as 3 : 1 respectively; qualitative analysis showed HO, CaO, BO_3, NaO; in several specimens, the microscope showed distinct prisms; hence the mineral is concluded to be natroborocalcite.

Comparison of theoretical and actual percentages from formulas and analyses of this mineral by Lunge and How.*

How's original formula, $NaO\ 2BO_3+2CaO\ 3BO_3+15HO$.
Lunge's " " $2(NaO\ 2BO_3)+5(CaO\ 2BO_3)+42HO$.

	Lunge.		How.	
	Calc.	Found.	Calc.	Found.
Soda,	5·82	5·58	7·82	7·21
Lime,	12·95	12·69	14·12	14·20
Magnesia,		·50		
Water,	35·49	36·85	34·04	34·49
Boracic acid,	45·74	44·38	44·02	44·10
	100·00	100·00	100·00	100·00

As regards *all* the constituents, I see no reason, on comparison of statements, to accept Dr. L.'s formula in place of my own.

2. *Pteropodes Siluriens de la Bohême,* Introduction. (Extrait du Syst. Silur. du Centre de la Bohême, vol. iii); par Joachim Barrande.—The Geologist Barrande here announces the publication of vol. iii of his great work on the Bohemian Silurian System, treating of the *Pteropods of the Paleozoic.* The volume is illustrated by 16 lithographic plates. The author admits among Silurian Pteropods, 9 genera and 246 species; 83 species of the genus *Conularia,* 52 of *Tentaculites,* 84 of *Hyolithes* (Eichwald), 3 of *Hemiceratites* (Eichw.), 4 of *Coleoprion,* 7 of *Pterotheca,* 3 of

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* See Chem. News, Feb. 22 and Ap. 19, 1867.

Salterella, 9 of *Styliola*, 1 of *Phragmotheca*. Seven out of the 9 genera are represented in the Bohemian rocks, while the United States, Britain, and Russia, have afforded each only four. Barrande refers these Pteropod genera to the Cephalopods. He states that the plates already engraved for his volumes on Bohemian fossil Cephalopods number *four hundred.*

3. *Musée Teyler:* Catalogue systématique de la Collection Paléontologique, par J. C. Winkler. Cinquième et Sixième Livraisons. Harlem, 1867.—These two parts complete this valuable work, which is one of the best catalogues of the kind ever published.

4. *Siluria: A history of the oldest rocks in the British Isles, and other countries, with sketches of the origin and distribution of Native Gold, the general succession of Geological Formations, and changes of the Earth's surface;* by Sir Roderick Impey Murchison, Bart. K.C.B., etc. 566 pp. 8vo, with 41 plates. London, 1867. (John Murray, Albemarle street).—Siluria is a work of universal interest—as it treats of the foundation rocks and earliest life in geology, and of all countries. Its illustrious author who early began to write out the history, passed it through its third edition in 1859, and now has brought it up to the present time and issued the fourth. The present volume contains besides additions of facts from Great Britain, Europe, and other eastern continents, much from the labors of Sir William Logan in Canada, to whom the work is dedicated.

5. *Materialien zur Mineralogie Russlands*, von Nikolai von Kokscharow.—The fifth volume of this great work of General von Kokscharof on Russian Mineralogy has been received by us, to page 192. It contains appendices to many of the species before described; and also general and crystallographic descriptions of the following minerals: Celestine, Chrysolite, Leuchtenbergite, Chalcolite, Kaemmererite, Psilomelane, Chrysocolla, Chalcophyllite, Limonite, Orthoclase, Copper, Nickel, Laumontite, Stilpnosiderite, Zoisite, Andalusite, Native Platinum.

III. BOTANY AND ZOOLOGY.

1. *Botanical Necrology for the year* 1867.

Dr. Henry P. Sartwell, died at Penn Yan, New York, on the 15th of November, at the age of 75 years. He was, we believe, indigenous to the western part of the State of New York, and when a medical student resided at Gorham, Ontario county. More than forty years ago he was established as a physician in the neighboring town of Penn Yan, where he passed his honorable and useful life, engaged to the last in the practice of his profession. It is said that the illness of which he died was brought on by overexertion in attendance at the bed-side of a sick friend. He was fond of all branches of natural history, and a diligent observer and collector in more than one; but in botany, he has secured an enduring reputation. He was in his way a model local botanist. He thoroughly explored the district within his reach; he prepared admirable specimens in great numbers, and distributed them with a free hand. Few botanists in this country have contributed to so many herbaria, home or foreign, none more disinterestedly and generously. He accumulated a large herbarium, specially rich and attractive in plants of Western New York, in Carices and Ferns. Desirous of ensuring its preservation and future usefulness, and needing in his old age the very moderate sum which it would bring him, he a few years ago transferred his herbarium to Hamilton College, where it is valued and well-cared for. Most local botanists, when they have nearly exhausted the resources of the district they are confined to, are liable to sink into inactivity. Dr. Sartwell avoided this destiny, and prolonged to the last his enjoyment and usefulness, by making a speciality of the great genus *Carex*. Dewey, Torrey, Tuckerman, Carey, Boott, all who have published within the last thirty years upon this genus, have had frequent occasion to acknowledge their obligations to him; and he erected for himself a monument of his zeal and devotion, and a testimony to his powers of observation, in his *Carices Americæ Septentrionalis Exsiccatæ*, the first part of which was issued in the year 1848, the second in 1850; while his interest and activity in the study continued with little abatement down to the last year or two. He published nothing else, we believe, excepting a *Catalogue of the Plants growing in the vicinity of Penn Yan*; but he contributed no little to the value of the publications of others, especially to those of the writer of this notice and to the Flora of the State of New York. The *Carex* which had been dedicated to Dr. Sartwell has proved to be identical with an old European species; but a very distinct and peculiar genus of Compositæ found in S. W. Texas, keeps up the name of *Sartwellia*. His most intimate associate in caricological study survived him only one month.

Professor CHESTER DEWEY, died at Rochester, New York, December 13, having completed the 83d year of his age. "He was born at Sheffield, Massachusetts, Oct. 25, 1784; was graduated at Williams College in 1806; studied for the ministry; was licensed to preach in 1808, and during the latter half of that year officiated in Tyringham in Western Massachusetts. The same year he accepted a tutorship in Williams College, and in 1810 was appointed Professor of mathematics and natural philosophy, an office which he discharged for seventeen years. During his connection with the College he did much to advance the standard of scholarship and enlarge the cause of study in his own and kindred departments. Between 1827 and 1836 he was principal of the "Gymnasium," a high school for boys in Pittsfield, Mass. In the latter year he removed to this city [Rochester], and became principal of the Rochester Collegiate Institute, which post he held until 1850, when he was elected Professor of chemistry and natural philosophy in the Rochester University. He was actively engaged in the duties of that position till 1860, when he retired at the age of seventy-seven, though he continued to teach to some extent till his eightieth year. The last four years he has passed in easy and dignified retirement, happy in the society of his family and friends, beloved and respected by all, and occupying himself still with his scientific studies and with meteorological observations, which he conducted with great care and regularity."

Dr. Dewey was an early and a frequent contributor to this Journal, upon several subjects, but especially upon that with which his name is inseparably connected, the *Carices* of North America. His *Caricography*, commenced in 1824, was continued year after year with few breaks, down to the close of 1866, when it terminated with a general "Index to Species." It is not for us to speak particularly of the merits of this elaborate monograph, patiently prosecuted through more than forty years. This and the monograph of Schweinitz and Torrey laid the foundation and ensured the popularity of the study of Sedges in this country. But while the latter, systematic in arrangement, was published as a whole in 1825, Dr. Dewey's, carried on without particular order, extended through a life-time, and represents both the earlier and the later knowledge. What is needed to render these stores of observation and their permanent results most available, is a systematic digest or synopsis, something like that which the author contributed to Wood's Botany, in the article *Carex*, but with all the more important references. Hopes were entertained that he might be able to crown his life's work in this way. But at past four-score and ten this could not well be expected. Beyond this favorite genus, Prof. Dewey's botanical writings were few; the most considerable was his *History of the Herbaceous Plants of Massachusetts*, published under the authority of the State, being the companion volume to the better known Report on the Trees and Shrubs, by Mr. Emerson. Botany was one of the occupations of Prof. Dewey's leisure hours; his long life was mainly devoted to education. Turning his attention to a special yet almost inexhaustible subject, however, and laboring perseveringly and faithfully, although under many disadvantages, he has permanently and honorably impressed his name upon the science, in which the Californian Umbelliferous genus *Deweya* has recognized his services. He was an excellent, simple-hearted, devout man, a fine specimen of the Western New Englander of the Old School.

The lovers of *Carex*, so numerous in this country, will cherish the memory of these two venerable men, Sartwell and Dewey, long associated in congenial pursuits, and gone to their rest together. May the turf of the sedges they loved, and which cover, or ought to cover, the low mounds under which their dust reposes, keep them perennially green, and adorn them each returning spring with their sober blossoms! A. G.

Our accustomed notices of European and other botanists deceased, not having been fully made up for the year 1866, we include in the following brief announcement the principal names.

Prof. GEORGE H. METTENIUS, of Leipsic University, the most promising if not already the best Pteridologist of the day, son-in-law of Prof. Braun, died of cholera, August 18, 1866, in the 43d year of his age.

Prof. D. F. L. von SCHLECHTENDAL, of the University of Halle, the venerable editor of the Linnæa and of the Botanische Zeitung, long an active botanist (the published list of his articles and other works reaches the number of 154), died October 12, 1866, at the age of 82 years.

Dr. THEODORE KOTSCHY of Vienna, a well known explorer in the East, author of a Monograph of Oriental Oaks, and other publications of merit, died June 11, 1866, at the age of 53.

Prof. WM. GASPARRINI, of Naples, died about the close of the year 1866, at an advanced age.

Dr. OTTO BERG, of Berlin, author of a Monograph of *Myrtaceæ*, and of several works upon pharmaceutical botany, died in November, 1866, at the age of 51.

GUSTAVUS MANDON, an excellent botanical explorer and collector, who distributed extensive collections made in Bolivia, died at Poitiers, France, December 30, 1866.

Dr. CHARLES G. B. DAUBENY, Professor of Botany and Rural Economy in the University of Oxford, died on the 12th of December last. A. G.

2. *The Journal of Anatomy and Physiology.**—The existence of this journal dates back one year, but the slight attention which it has received on this side the Atlantic has led to the preparation of the following notice.

The first series consists of two numbers issued in Nov. 1866 and May 1867, and embraces 378 large octavo pages and 15 lithographic plates distributed among 27 articles, about one-fifth of the space being devoted to Reviews, Reports on the progress of Anatomy and Physiology and notices of recent Dutch and Scandinavian contributions. In addition to the distinguished professors under whose care the journal is to be continued, the 1st series bears the names of Alfred Newton, E. Percival Wright and J. W. Clark. The expectations raised by the announcement of its scope and purpose and by the names of its conductors are well justified by the variety and character of its contents. The opening article of the 1st series, the address of Prof. Humphrey before the Physiological section of the Nottingham meeting of the British Association, is remarkable in general for its freedom from the scientific mutual admiration which so often mars such productions, and in particular for the equal ability and fairness with which it discusses the great problem of the day, the origin of species, and for the much-needed suggestions to those who dread each onward step in Science as an attack upon religion, that "true religion is unassailable, its foundation being laid deep in man's consciousness and God's work," and that it does not consist in "drawing arguments from analogy and in insisting upon certain literal interpretations of the physical medium through which spiritual truth has been conveyed to us."

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* Conducted by George M. Humphrey, M. D., F. R. S., Professor of Anatomy in the University of Cambridge, and Wm. Turner, M. B., F. R. S. E., Professor of Anatomy in the University of Edinburg. Second Series, No. 1. Nov. 1867. Macmillan & Co. (In half-yearly numbers, at six shillings each.)

Prof. Humphrey (we presume) also contributes a long and impartial review of Owen's Anatomy and Physiology of Vertebrates, in which, while generally admiring this last work of the great anatomist, he regrets the continuance of the unhappy controversy as to the peculiarities of the human brain, and comments upon the apparent non-recognition of the really unsettled state of opinion upon two important points in homology concerning which Prof. Owen holds very decided opinions, viz., the morphological relations of the scapular arch of all vertebrates with the skull, and the homology of the fore and hind limbs. Upon the latter question, Prof. Humphrey is eminently well qualified to speak, for he was the first English anatomist to recognize, though from a functional point of view, the antagonistic relation of at least the proximal segments of the limbs, which nearly all anatomists attempt to force into a parallel position, and which Prof. Owen, like Barclay and Flourens, regard as simple serial repetitions of each other, the *convexity* of the knee corresponding with the *concavity* of the elbow, and *vice versa.*

Mr. John Wood has an interesting paper on human muscular variations, in which he shows that many of them are comparable with normal conditions in the lower animals, but adds the startling, and, we think unwarranted, suggestion that those variations which cannot be so referred may be "indications of a higher development of the human frame" in time to come.

Prof. Huxley describes two skulls of which one is the widest, the other the narrowest, he had ever seen; yet the sagittal suture was completely obliterated in the former, and open in the latter, showing that in these cases, at least, the form of the skull was determined by something besides the condition of the sutures.

Prof. Turner adds a fourth to his three cases already reported by Prof. Wyman, Dr. Günther and Prof. Agassiz, of male fishes carrying the ova in the mouth during incubation.

No. ii. opens with a very interesting account by Mr. Flower and Dr. Murie of the dissection of a Bushwoman, whose characteristics, especially the proportion of the limbs, showed no approximation toward what are generally regarded as pithecoid features of the colored races; the spread of the arms was full two inches *less* than the height of the body.

Dr. Cleland advances some weighty arguments against the soundness of the generally accepted theory of the intercostal muscles.

In a valuable and suggestive paper on the anatomy of the Chimpanzee, Prof. Humphrey discusses at some length the significance of the terms "hand" and "foot" and inclines to think the name "Cheiropoda" more appropriate than Quadrumana. He also alludes to the "high function" of the foot and of all the human organs, adding that his feelings on the subject incline him "rather to search for and overrate than to ignore the physical peculiarities of man." But while it is certain that in pure Anatomy and Physiology, we ought to insist strongly upon the functional or teleological value of organs, and are justified in seeking for physical peculiarities commensurate with the psychical endowments of man, yet it seems to us that for zoological purposes, functions must be wholly ignored and that we have really no alternative between the entire separation of Homo from the rest of creation on account of his having an immortal soul, and his admission as an animal not only into the type of vertebrates, and the class of mammalia, but also into whatever order, or even family, may be warranted by purely structural considerations. Teleologically man is a spiritual being, a discrete degree above the beasts that perish, but morphologically, (and nothing but morphology is of value in classification) he is at least an animal, a vertebrate, and a mammal.

Space will not permit a special notice of the other articles. No. 1, of the 2d series, just received, is reduced slightly in size and in the number of plates, and considerably in price, though it contains more pages than either of the preceding numbers, and is quite as valuable for both the variety and character of the articles. Mr. Mivart concludes an exhaustive survey of the osteology and classification of the Insectivora; there are anatomical papers by Prof. Turner, Dr. MacAllister, Dr. Hair and Dr. Dohrn, cases of deformity with morphological and physiological deductions therefrom by Prof. Humphrey, Dr. Chiene and Mr. Goodman, with several microscopical and physiological papers, and the usual Reports on the Progress of Anatomy and Physiology; while as in the other numbers, the concluding pages are devoted to notices and abstracts of recent Dutch and Scandinavian contributions to those sciences.

The value of these reports and notices can hardly be over-estimated, and indeed, if we would make any suggestion of a change, it would be to increase their number and completeness, even if it involved the omission of some special papers, which, though very important, do not readily furnish material for thought and would not lose by waiting for a little later appearance in the Transactions of societies: we may add too, the wish that this journal may in time be issued quarterly, so that we may be as soon as possible informed upon the progress of science all over the world. Nowhere is this information more needed than in America; next to the deficiency in the number of workers, the great defect of our Science lies in our slight acquaintance with, and recognition of, the labors of our co-workers abroad, especially in France and Germany. Not that the same thing does not exist elsewhere; indeed a good illustration exists in the paper of Dr. Lighbody in No. 1, where are described little bodies connected with the nerves of the cornea, which Prof. Krause (No. ii, p. 346,) states have been described or referred to four times since the year 1858 in both French and German publications. The success, therefore, of this or of any journal which shall not only give us in detail the labors of its contributors but shall keep us posted upon the progress of science everywhere, and so both show us where to look for desired information and prevent our doing over what has been done before, is most earnestly to be wished for; and though we in America, may feel, and justly, that we have now a competent scientific tribunal, and that we neither need nor ought to send our contributions to other lands for judgment, yet it by no means follows that we are independent of the information they offer; nor will it prevent our being severely criticised if we persist in rediscovering what is already well known, and in elaborating what is already thoroughly understood. And while we trust the time is not far distant when America shall have her own journal of Anatomy and Physiology, yet till that time comes we must either avail ourselves of what is offered by other countries, or be continually behind the times. B. G. W.

3. *On the actual state of our Information relative to the 'Leporide,' or Hybrid between Hare and Rabbit*; by Dr. PIGEAUX.—Are there any sexual relations between the hare and rabbit in a state of nature to which it would be possible to attribute the creation of a mixed or intermediate species, to be named on account of external configuration, *Leporide?* The ancients, and indeed some of the moderns, deceived by the colors and special forms of certain varieties of rabbits common in the south of Europe and very abundant in Asia Minor, have believed this to be the case. Such varieties are found in some departments of the east of France and along the banks of the Rhône. These are, after all, merely rabbits which burrow, and are born without fur and with the eyes closed. Such are the *Léporides* of M. Roux, and those also which have been and are perhaps still called 'Leporides' at the Jardin d'Acclimatation in Paris. These rabbits pair voluntarily, and are productive either amongst themselves or in conjunction with the ordinary domestic rabbit. I have had in my possession some of them which, from their appearance, might almost have been mistaken for hares, having the tip of the ears black and the inferior surface of the belly and of the thighs tawny; nevertheless, by all characters distinctive of the species, they were never anything but rabbits. Thus I am able to negative the pretensions of M. Roux to having created a race of fertile hybrids begotten through a male hare and several female rabbits.

It is, however, by no means difficult to bring about a connexion between the hare and rabbit in a state of domestication; but for success we must not persist in uniting adult individuals unaccustomed to living together previously. In such a case the female nearly always kills the male, bleeding him at the jugular, or, unless the hutch be securely fastened, succeeds in dislodging him. This will occur indeed sometimes when a young male leveret has been brought up with young female rabbits, as soon as they become adult, if the cage be to constrained in its dimensions. In order that the experiment may succeed, it is necessary to provide a cage of a certain extent, say of some meters, barred in some portions and pannelled in others, so that the animals may escape observation at pleasure. It is well also to leave several females with the young male, in order that he may have some range for choice. Such measures were adopted by M. ——, of Nanterre, near Paris, whose success has been as complete as it is perfectly attested and indubitable. Several female rabbits were rendered pregnant by the agency of a single male hare existing in his menagerie; he has further been able to rear to the adult state a number of the *mongrels* or, rather, *mules* so obtained between the two species. There were both males and females, apparently strong and well developed; and these paired, but have not been productive, as far as I know, hitherto. I would not deny to these mongrels a fecundity similar in degree to that which is sometimes found in the cross between ass and mare; but such a case is only exceptional, and we can neither fear nor indeed hope to create a new race: so that from this point of view the *Leporides* do not exist.

The instance cited by M. Albert Geoffroy Saint-Hilaire, in which a female hare covered by a male rabbit gave birth to a young already covered with fur, and having the eyes open, is a most remarkable one; it could, however, be merely a case of a cross retaining the form of the mother, and no more fertile than in the case of those hybrids between the ass and the horse in which the latter animal (the male) gives the predominant character to the offspring.

These experiments may be repeated and varied, proceeding with very young animals brought up together and enjoying a certain liberty, although confined in the hutch. It is of especial importance, in breeding with the male hare, to provide several females, whether of rabbit or of hare, always, however, isolating them as soon as they are ready to bring forth (in twenty-eight or thirty days). That the hare, when in good condition will produce several times a year admits of no doubt; but as she does not burrow, it is necessary to furnish her with a sufficient quantity of twigs, and to keep them extremely fresh and clean. Although in captivity the hare usually produces only one or two young, she has been known to bring forth three, and to rear them with great tenderness; it is, however, necessary to remove them early from the male, and even from the female, who will often strangle them as soon as they are capable of living independently, especially if they are about pairing again.

The rearing of hares in captivity is but a thankless task, as they do not live long, wanting a sufficient space for running; their flesh, also, is insipid, unless, indeed, they are let loose some months previously in an area perfectly free from rabbits; for between these two species there rages a most inveterate war; and a single rabbit would with ease strangle fifty hares in one night. The female, also, is not very productive, and ceases to bear after the third year.

To sum up, therefore, we would affirm that *Leporides* exist undoubtedly under both forms, with predominance of the hare or of the rabbit; but as a species, or even a variety, we cannot admit them, since, like all other crosses, they have merely an accidental productiveness. Their utility moreover is but slender, the flesh having neither the whiteness of the rabbit nor the fine flavor of the hare. Pretty much the same thing may be said of the hares reared in hutches; their flesh lacks flavor, and their multiplication s too limited to render them a profitable object of industry.—*Bul- stin mensuel de la Société Impériale zool. d'Acclimatation*, 2^{me} érie, tome iii. No. 7, July 1866.—*From the Ann. Mag. Nat. Hist.*, II, xx, 75.

3. *A History of the Fishes of Massachusetts;* by **David Hum-HREYS Storer**, M.D., A.A.S., etc. Reprinted from the Memoirs f the American Academy of Arts and Sciences. 288 pp. 4to, with 9 lithographic plates. Cambridge and Boston, 1867. (Welch & Bigelow, and Dakin & Metcalf).—The first Report of Dr. Storer n the Fishes of Massachusetts, was prepared in 1839, and issued without illustrations. Since these his preliminary labors, he has given the subject a thorough investigation, and in the papers of which this volume consists, presents his completed work, containing new descriptions of all the species, with admirable lithographs of over 130 species by Professor Agassiz's skillful artist, Mr. Sonrel. The work is one of great value to all interested in Zoological science, and is especially important to those who wish to learn anything about the fishes of the American coast.

4. *Index to vol. I to XI, of Observations on the Genus Unio*, together with Description of new species of the Family Unionidæ; and Descriptions of new species of the Melanidæ, Paludinæ, Helicidæ, etc., read before the American Philosophical Society and the Academy of Natural Sciences of Philadelphia, from 1827 to 1863: by **Isaac Lea**, LL.D., etc. 64 pp. 4to. Philadelphia, 1867. —This elegantly printed Index forms a fitting close to the long series of contributions to Zoology, which Dr. Lea, at large personal expense, has been making through the past *forty* years. The Index, as the prefatory notice states, was prepared for the author of the work by his friend James Lewis, M. D., of Mohawk, N. Y., of whom he adds, "whose thorough knowledge in this branch of Natural History is so well known."

IV. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Earthquake in Kansas;* by **John D. Parker**, Prof. Nat. Sci. Lincoln College, Topeka, Kansas. (Communicated for this Journal.)—The earthquake of April 24, 1867, was more severe and extensive in its effects than any other which has occurred within the memory of the oldest inhabitant. Between one and three o'clock on that calendar day, two distinct earth-waves passed over the State of Kansas, together with large portions of the States of Nebraska, Missouri, Illinois, Indiana, and are reported to have reached Ohio. Almost the entire population of two or three of the first named States was precipitated in one hurrying mass into the streets. The most massive buildings swayed back and forth and seemed ready to fall. A train on the Pacific railroad was stopped, the engineer and fireman jumping off under the impression that the engine was on the point of blowing up, clocks were stopped, and animals hurried about the fields in alarm, while some stood still in the furrow. The earthquake was accompanied by a noise likened by

some to the roar of distant thunder, or to the rumbling of artillery over a pavement. A large mass of material, referring to it has been collected, out of which the following brief abstract is made.

The *time* of the shock at Topeka, Kansas, was about fifteen minutes to three o'clock. At the Agricultural College, Manhattan, it is noted as having occurred at thirty-two minutes past two o'clock. At the State University, Lawrence, it is reported to have occurred at about three minutes to three o'clock by the town clock, which is generally a little fast. Making allowance for different meridians the time of occurrence was later as we go eastward.

The *duration* of the shock was from ten to thirty seconds. In western Kansas it was about ten seconds in length, but gradually increased to thirty seconds or more in its progress eastward.

The *direction* of the shock appeared to be from the south or southwest to the north or northeast. This is shown from various facts, the principal one being the movement of the water in the Kansas river. At Manhattan the water of this river was observed to roll in a heavy wave, at least two feet high from the southerly to the northerly bank, while no similar movement was noticed in the Big Blue which empties into the Kansas river from the north at the same place. This fact has been thoroughly substantiated by Prof. Mudge of the State Agricultural College. It rests upon the testimony of several credible witnesses and is decisive. In confirmation of the same, light articles, such as photographs, when piled upon each other, were pitched over toward the southwest. Waves in the ceiling of Lincoln College were observed to run from the southwest toward the northeast. Rev. R. D. Parker, attending the dedication of a church at Warrensburg, Missouri, at the time, observed the walls of the church heave as if moved by a shock from the southwest.

The *number* of shocks seemed to vary in different places. At the initial point in western Kansas, or eastern Colorado, there seems to have been one shock increasing in intensity and gradually dying away. As the movement progressed eastward the original impulse seems to have separated into two distinct earth waves, which again appear to have faded into each other as they became less violent.

The *movement* of the earth-wave was mainly that of translation. The slight damage done by the earthquake, otherwise so violent and extensive, is probably due to this fact.

The *velocity* of the movement of the earth-wave was great. This is shown by the small difference of time elapsing between the occurrence of the shock at comparatively remote points. The telegraph operator at Topeka, on the Pacific line, states that reports of its occurrence seemed to come indiscriminately immediately after the shock, both from the west and the east.

The *effects* of the earthquake as already indicated, were alarming but not serious. Several persons were more or less injured, but not a life is known to have been lost. Two contiguous blocks in Leavenworth are reported to have been lifted up and separated several inches, but they settled back again apparently uninjured on the passage of the earth-wave. Two large stones were loosened from the top of the Unitarian church in Lawrence and precipitated to the ground, and the walls of many buildings in different places were cracked, but not one is known to have been thrown down. At Topeka, a funeral service was occurring in one of the churches which was crowded to overflowing. As the stone building was rocked to and fro, the people made a hasty escape in every available direction, many of them jumping through the broken windows. An acre of ground three miles south of Carthage on the Miami canal, is reported to have sunk ten feet, showing that the shock extended to Ohio. The ground sunk bodily, leaving a perpendicular wall of ten feet or more on all sides. The canal bank was seriously endangered by the subsidence.

2. *On the Volcanic eruption near the city of Leon;* by Hon. A. B. Dickerson, United States Minister to Nicaragua, dated Leon, Dec. 4, 1867, (from a letter addressed to the Secretary of State, Washington).—On the 14th of November last a new volcano broke out in Nicaragua, about eight leagues to the east of the city of Leon, on a crowded line of volcanos running through the State parallel to the Pacific coast.

It commenced about one o'clock in the morning with a succession of explosions, which were distinctly felt and heard at Leon. These explosions opened a fissure through the earth crust about half a mile in length, running from the old fissure in a southwest direction, about midway between the extinct volcanos of Las Pilas and Orota, which are two of the numerous cones studding the ancient fissures.

Before daylight on the morning of the 14th, fire was seen issuing from the new volcano in various places. The explosions continued irregularly during the whole time that the volcano was in a state of eruption, sometimes in rapid succession, and at other times at intervals of half an hour. Low, rumbling sounds were heard almost incessantly. In the course of a few days two craters were opened on the new fissure, about a thousand feet apart, the one at the southwestern extremity discharging perpendicularly, and the other shooting out toward the northeast at an angle of forty-five degrees. The flames [?] from these two craters increased in size and height, while jets of flame and slighter discharges were emitted from two or three other side fissures.

On the morning of Nov. 22d, I went to the new volcano for the purpose of observing it more closely, though I had seen and heard it every day and night from Leon. The best view I obtained of it on that occasion was just before daylight from a mountain summit, about one mile to the northeast of the fissures and at right angles with it. The main crater at the right was actively at work throwing out flames and half-melted cinders through a circular orifice about sixty feet in diameter, which was constantly filled to its utmost capacity with the ascending masses. A regular cone, built up entirely by the falling cinders to the height of about 200 feet, had already formed around the crater.

The rim of the cone was white with heat, and the outside was red hot for half way down, while the remainder of its background work was glittering with innumerable glowing sparks. It was puffing quite regularly about once a second with a strong, constant blast, which kept up a column of flame filled with flying cinders, to the height of about 500 feet above the mouth of the orifice. Irregular explosions occurred at intervals, varying from ten to thirty minutes, increasing the force and volume of the discharges, and sending them far up into the rolling clouds above. The cinders went up in half-fused blazing masses, from one to three feet in diameter, and came down upon the cone hardened, striking with a clinking metallic sound. After daylight the red appearance of the cone changed to bluish-black. The left-hand crater was shooting out oblique discharges of flame of a similar character at an angle of forty-five degrees from the other, and evidently communicated with it about a thousand feet below the surface, the two craters being that distance apart and both discharging simultaneously. The half horizontal crater was about twenty feet in diameter.

On the afternoon of the 27th, after a series of explosions which seemed to shake the earth to its center, the volcano commenced discharging vast quantities of black sand and heavier rocks. The column of flame at night was considerably increased in height, and bright meteor-like spots were seen ascending in the flames to the height of not less than 3,000 feet. These were large spherical stones four and five feet in diameter. The next morning the streets and house-tops were covered with fine black sand from the volcano, and a vast luminous cloud of raining sand overspread the whole surrounding country. The rain of sand continued until the morning of the 30th, when the volcano died away, apparently exhausted by its eruptions. The sand now covers the whole surrounding country from the volcano to the Pacific, a distance of more than fifty miles from it. At Leon it is from an eighth to a quarter of an inch in depth. As we approach the volcano it gradually grows deeper and coarser. For a mile around the crater it lies in particles from three-eighths to half an inch in diameter and about a foot in depth. Still nearer to the cone the sand increases to several feet in depth, and the particles gradually increase in size until they become small broken rocks. About the base of the cone round heavy rocks from four to five feet in diameter lie thickly scattered, but much the larger portion of them are broken into fragments. The cone itself is 200 feet in height, with a crater in the top 200 feet in diameter and about the same number in depth. The inside of the crater, as well as the outside, is covered with hard broken rocks, generally less than a foot in diameter. A long ridge of black scoria leads out from the branch crater in a northeasterly direction. The slaggy lava-like scoria which first issued from the main crater is now principally covered up by the hard igneous rocks which came out from the profounder depths with the last discharges. The forest for leagues around is scarred and maimed by the sharp-cutting storms of sand, and near the volcano the trees lie cut into numerous fragments, half buried under the sand and rocks. The volcano was an active and interesting sight for 16 days, and now in its repose affords an ample and instructive field for the geologist. Indeed, no country in the world presents a more interesting study than the plain of Leon. Twenty volcanic cones are seen rising from it at a single view. Its soil is unequaled in fertility, as finely pulverized and as evenly distributed as that of the valley of the Nile or the Mississippi; not, however, by water, but by fire! It has literally rained down from the volcanos, richly freighted with fertilizing materials.

Humboldt regretted before his death that men of science had not more fully investigated this remarkable region of country, and it is sincerely to be hoped that it may not much longer remain neglected by them.

The recent fall of sand has been followed by a shower of rain, and though a few days have since elapsed, corn, cotton and grass have grown more rapidly under its fertilizing influence than I have ever seen plants grow before. Some weeds and plants it kills; others it starts forth with renewed life and vigor.

I send herewith a specimen of the sand gathered at Leon before the rain, hoping that it may be analyzed. [The sand consists of grains of scoria, chrysolite and a feldspar].

It may be proper in this connection to call attention to the recent destructive storms, earthquakes and eruptions which occurred in and around the island of St. Thomas during the same period of time which I have been describing, and which undoubtedly sprang from the same general cause, as those earthquakes were distinctly felt at Leon.

2. *Earthquake at St. Thomas.* (1.) From Commodore Bissell's official Report to Rear Admiral J. S. Palmer, of the loss of the United States Steamer Monongahela, dated United States Steamship Monongahela, St. Croix, Nov. 21, 1867.—I have to state, with deep regret, that the United States steamship Monongahela, under my command, is now lying on the beach in front of the town of Frederickstadt, St. Croix, where she was thrown by the most fatal earthquake ever known here. The shock occurred at 3 o'clock P. M. of the 18th inst. Up to that moment the weather was serene, and no indication of a change showed by the barometer, which stood at 30 degrees 15 minutes. The first indication we had of the earthquake was a violent trembling of the ship, resembling the blowing off of steam. This lasted some thirty seconds, and immediately afterward the water was observed to be receding rapidly from the beach. In a moment the current was changed and bore the ship toward the beach, carrying out the entire cable and drawing the bolts from the kelson, without the slightest effect in checking her terrific speed toward the beach. Another anchor was ordered to be let go, but in a few seconds she was in too shoal water for this to avail. When within a few yards of the beach the reflux of the water checked her speed for a moment, a light breeze from the land gave me a momentary hope that the jib and foretopmast

staysail might pay her head off shore, so that in the reflux of the wave she might reach waters sufficiently deep to float her, and then be brought up by the other anchor. These sails were immediately set, and she paid off so as to bring her broadside to the beach. When the sea returned in the form of a wall of water twenty-five or thirty feet high, it carried us over the warehouses into the first street of the town. This wave in receding took her back toward the beach, and left her nearly perpendicular on the edge of a coral reef, where she has now keeled over to an angle of fifteen degrees.

All this was the work of a few moments only, and soon after the waters of the bay subsided into their naturally tranquil state, leaving us high and dry upon the beach. Providentially only four men were lost: these were in the boats at the time the shock commenced. * * * * * Persons looking at the ship from shore declare that the bottom of the bay was visible where there was before, and is now, forty fathoms of water.

(2.) Communication to the Secretary of State from OTTO FREDERICK RAUPACH, of St. Thomas, dated Dec. 28th, states the following facts as introductory to a full list of all the shocks, with their time of occurrenee.

The 18th of November was a beautiful clear day, with a fine blue West India sky. The wind was east-by-north, but there was very little of it. The ocean was quiet; there was almost a calm. The sun shone bright and warm, and the barometer stood at 24° Reaumur, in the shade. There was not the least sign of any kind to foretell this great convulsion in nature, when suddenly, at about a quarter of 3 o'clock in the afternoon, there was heard an underground rumbling noise, which was immediately followed by a terrific earthquake, which seemed to come from south-by-west, and pass on to the north-by-east. The earth seemed as if composed of small waves rising and sinking under your feet, so that if you made a step forward, your foot seemed to meet higher ground, and if you put it backward it also there met higher ground. To stand still in one spot was impossible, and when trying to walk it was as if something kept you back. The underground sound, while the first shock was going on, for about one minute and a half, was most dreadful. It terrified every living soul. The sun seemed at once to become dim; it was as if eclipsed, and this dimness lasted that first day until sunset, and continued the whole of the next day, but in a less degree, and it only wore away entirely in the course of two days more. It was as if the sun, though apparently as bright as usual, had lost some of its warming and illuminating power. After the first terrific shock the ground continued groaning and trembling, when, about ten minutes after, a second strong shock was felt. Directly after this second shock the ocean, which shortly before the first shock had receded from the land several hundred feet, was seen to rise like one huge wave and come in toward the harbor. It stood up like a straight white wall, about from fifteen to twenty feet high, and advanced very fast into the harbor, sweeping or upsetting small vessels before it, and raising the large men-of-war and steamers to its top. The appearance of his wave was like a white masonry wall, erect and straight as if uilt with the aid of a rule; it had not the appearance of ordin-ry waves. It broke in over the lower parts of the town to the eight of a couple of feet and to the extent of about two hundred nd fifty feet inland, according to the level of the locality. The ising of the waves was repeated a second time after an interval f about ten minutes, and the second appeared to be even a little arger than the first, and went a little further inland. After these two waves had passed away, the ocean remained, as far as the eye could see, quite calm again, just as it was before the first shock of the earthquake had occurred.

The shocks continued and were felt every few minutes. It was as if the shocks of the first day hung together in one chain, but from 2:45 o'clock on the morning of the 19th of November, the shocks were felt more separately and distinct, and, therefore, seemed as if they were more frequent.

From 2:45 o'clock p. m. on the 18th till 2:45 o'clock a. m. on the 19th, there were eighty-nine shocks. From 2:45 o'clock a. m. on the 19th till midnight, there were two hundred and thirty-eight shocks. The shocks became less severe from the 21st of November.

3. *Earthquake in Western New York, Vermont and Lower Canada.*—On the morning of Wednesday, the 18th of December last, at about 3 o'clock, a severe shock of earthquake was felt at Montreal, Burlington and other places in Vermont, and over a distance of 400 miles to the west. The shock is stated to have lasted 20 seconds at Burlington, and a minute and a half at Syracuse, N. Y. The shock is described at Syracuse as like a succession of waves from the south to the north. At Hammond, N. Y., the first shock is stated to have occurred at 10 minutes before 3, others lighter followed; and at 4:27 was the final one, which was quite severe. It shook down crockery, and frightened many persons, but did no serious damage.

4. *Corrections to a paper "on the Comparative Strength of Cannon of modern construction,"* published in the VIIth volume of the Proceedings of the Academy; by Daniel Treadwell. (Extr. Proceedings Amer. Academy of Arts and Sciences, for Oct. 8, 1867).—In a paper "On the Comparative Strength of Cannon of Modern Construction," written by me in January, 1866, communicated to the Academy in September of the same year, and published in the last volume (the seventh) of our "Proceedings," I, by some inadvertence for which I am now unable to account, in computing the force of the 600 pounder, or 13·3 inch, coil gun, as constructed by Armstrong, described it as capable of bearing a charge of 100 pounds of powder.

Although this quantity of powder was no doubt fired in it, I know not how many times, yet it ought not by any means to be rated as its *service charge;* and I recognize it as an oversight in me to have taken it as such. In fact, I have no belief, that more than 70 pounds of powder should be assigned as the service charge of the Armstrong 13·3 inch gun; as no gun can be trusted for long continued firing with more than $\frac{70}{100}$ of the largest charge of powder which it may have withstood, and no *cast-iron* gun with so much as this.

I have not the data necessary to determine accurately the velocity, and consequently the force, which this reduction of the charge of powder must make in the shot; but if we take the force of the shot in the direct ratio of the weight of the charge of powder we shall have 261, instead of 372·8, as representing the "number of pounds of shot raised one foot by each pound of metal in the gun," as these numbers are in the ratio of 70 to 100.

I am not able to state what has constituted the greatest charge of powder borne by Armstrong's gun of 12 tons, carrying a shot of 300 pounds; but, reducing the charge of 60 pounds, as given by me, in the ratio of 70 to 100, we have a charge of 42 instead of 60 pounds of powder, and a consequent reduction of the force of the gun from 392 "foot pounds" to 273 "foot pounds."

I have thought it the more necessary to make this correction, as in a computation of the force of the Dahlgren & Rodman guns given in the same paper to which this is a correction, the quantity of powder then understood by me from all that had been published by government authority as constituting a service charge was taken as one of the factors in assigning the measure of the force to those guns. It is now claimed, however, to have been discovered that the Rodman gun is capable of withstanding much larger charges of powder than were authorized to be used when my paper was communicated to the Academy.

5. *Cretaceous Coal in New Mexico.*—In a letter from Prof. JOHN LECONTE, dated Fort Craig, New Mexico, Oct. 3d, 1867, he states that through the facilities afforded him by General W. W. Wright, Chief Engineer of the eastern division of the Union Pacific Railroad, he has been enabled to make an examination, and determine the age of the bed of anthracite near the Old Placer Mountain, twenty-five miles southwest of Santa Fe. Dr. LeConte has forwarded to us specimens of the anthracite and also of the unmetamorphosed coal from the coal mine eight miles east of San Antoino and the Rio Grande. He has determined by his investigations that they both belong to the older Cretaceous period, and are the same lignites mentioned by Dr. Newberry (Rept. Ives' Expedition) and Dr. Parry (Rept. U. S. Boundary Survey) as occurring in other localities in the Rio Grande valley. Dr. LeConte remarks, however, that the locality near the Placer Mountain is the only place in which this Cretaceous coal has been converted into anthracite, and that the cause of the metamorphosis is a stream of lava which has flowed over the rocks containing the coal bed, and has congealed into gray trachyte. The Cretaceous rocks dip nearly 30° in an easterly direction and the cleavage of the anthracite is vertical, bearing south. About a third of a mile from the anthracite locality is another exposure of the same vein in which the coal is much less altered from its original condition.

6. *On the introduction into the Mohawk River and Erie Canal of certain species of Shells not previously found in those waters.* Extract from a letter from Dr. J. Lewis of Mohawk, addressed o the Smithsonian Institution).—"For the benefit of future colectors, I would like to have recorded, that in the month of October and November, 1867, I placed in the Erie canal, and the Mohawk river at this place, several hundred living specimens of the Molluscs Mr. Binney calls *Vivipara contectoides.* A large share of these were placed in a wide and deep portion of the canal, nearly a mile east of the central part of the village of Mohawk, a few rods east of a point against which there has been a "*land slide*" from the adjacent bluff. A few were placed in the canal above the "upper lock and aqueduct" at Mohawk. In both instances near the south bank of the canal. A considerable number were placed on the south side of a wide curve in the river, several rods above the mouth of "Fulmer's Creek." These were distributed along the *muddy slope* in water about 3 to 4 feet deep, for a space of about five rods, the adjoining land belonging to Ezekiel Spencer, Esq. The western limits of distribution is near the center of the northern boundary of Mr. Spencer's lands.

At this place, also, were placed in the river a number of specimens of the shell Mr. Lea calls *Trypœrastinia Lewisii.* These shells were sent to me from the *Illinois river* for this purpose, by Mr. John Wolf, of Canton, Illinois.

I have hopes that this effort to colonize these species will prove successful, as they were all apparently healthy and active. A limited number of specimens of Vivipara were examined and found to contain embryonic young in various stages of development, but none ready for exclusion. Forty young, and over, were taken from one specimen an inch long. Other Molluscs have been solicited for similar experiments. Reports will be made when they are colonized.—(*Communicated by Prof. Henry.*)

7. *Observations on the transfer of the Library of the Smithsonian Institution to the Library of Congress;* by Professor Henry. (From the unpublished Report of the Secretary of the Smithsonian Institution for 1866).—Although the present condition of the fund is a matter of congratulation, yet there is another fact belonging to the history of 1866 of equal if not greater importance, in regard to the future efficiency of the Institution. I allude to the transfer of the Smithson library for safe-keeping and support to the Library of Congress. To those who have not fully considered the subject, it might, at first sight, appear that this transfer of a large number of rare and valuable books from the building of the Institution would be attended with serious inconveniences, and be a virtual relinquishment of the control of property procured at the expense of the Smithsonian fund. But it will be evident, on a statement of the facts, that the advantages accruing to the Institution and the public from the transfer far outweigh any inconvenience which may arise on account of it; and that it will tend to increase the efficiency of the funds, while it adds to the security and even facilitates the general use of the library.

Although the removal of the books renders them somewhat less accessible to those engaged in study and researches at the Institution, yet all the current transactions of the scientific societies of the world, which constitute the principal part of the library, will be still received at the Institution. An opportunity is thus afforded of noting their contents before they are sent to the Capital, and such books will permanently be retained as are of most constant reference. In addition to this, the Institution is to have at all times, the free use of the books of the Congressional library as well as those of its own, and for this purpose, and the better accomodation of the public, the library of Congress is to be open throughout the year, with the exception of a month for cleaning and examination. Hence the general student, instead of being debarred any important privilege, will find increased facility for research in having access, in the same building, to both libraries. Again, the east wing of the Smithsonian building, in which the books were deposited, is not fire-proof, and is liable to destruction by accident, or the torch of the incendiary, while the rooms of the Capitol are of incombustible materials. This wing was, moreover, filled to overflowing, and a more extended and secure depository could not be obtained, except by another large draught on the accumulated funds intended to form part of the permanent capital. Besides this, by the terms of the transfer, the cost of the care, binding, and cataloguing of the Smithsonian books is provided by government, and an important part of the annual income of the Institution is thus saved for other purposes.

But the advantages of the transfer are not confined to the Institution. The library of Congress has secured such an addition as cannot be obtained by purchase, since many of the books are presents from the duplicates of the old libraries of Europe, consisting of transaction and other publications of the learned societies of the world, forming a special collection, not only ranking as first in this country, but one of the best anywhere in existence. Neither is it alone the value of the books that have actually been transferred which is to be considered, but also the means which are offered, through our system of exchange, for the perpetual increase of the several series of works which contain the record of the actual progress of the world in all that essentially pertains to the mental and physical development of the human family. The transfer of the Smithson library has furthermore tended to awaken an interest in the library of Congress, which cannot fail, under the energetic superintendence of the present librarian, Mr. Spofford, in a few years to render it worthy of the national Capitol. An appropriation of $100,000 has been recommended* by the Joint Committee of the two houses of Congress for the purchase of the library of Mr. Peter Force, consisting of books relative to America. With these additions the library of Congress will be the largest in the United States, and the necessity of a separate building is even already foreshadowed.

* An act has been passed in accordance with this recommendation, and the library of Mr. Force is now the property of the Government.

But above all, the act authorizing the reception, care and support of the Smithson library may be considered as an approval by Congress of the general policy adopted and the course pursued by the Institution. It will be recollected that at the commencement a number of influential literary men warmly advocated the expenditure of the larger portion of the income of the Smithson fund in the establishment and support of a library. This plan was opposed on the ground that the Institution by the terms of the bequest should be of a cosmopolitan character, and produce results, the benefits of which would not be confined to one city, nor even one country, and which could not be accomplished by a library. The act of organization, however, was so expressed as to give color to the idea that a large library was intended by Congress, and much complaint was at one time made because more of the income was not expended in the purchase of books. The late legislation of Congress will leave no ground for further cavil in regard to this point, and while the Institution will be relieved from a large expenditure on account of the library, a national collection of books will be formed far more extensive than could possibly be supported by the Smithsonian fund.

Moreover, while thus relieving the Institution from a charge which has borne so heavily on its resources, Congress has afforded most encouraging evidence of an important advance in public opinion regarding the right interpretation of the terms of the Smithson bequest. It is substantially a recognition by the national legislature of the fact that the Smithson fund ought not to be burdened with the support of objects which, while they absorb the income, are locally restricted in their influence, and neither essentially connected with the design, nor authorized by the language of the trust. Since Congress has eventually thought proper to assume the care of the library we may cherish the hope that in due time it will also make provision for the separate maintenance of a collection of objects of "nature and art," not unworthy of the National Capital; and that the proceeds of a fund, now generally recognized as having been intended by the testator for objects of a higher order than those confined to local or even national benefit, will be entirely devoted to the system of operations which an experience of twenty years has abundantly shown to be the best and most practical means of realizing the design of the testator.

The propriety of making provision for the separate maintenance of a national museum, and of relieving the Smithson fund from the burden imposed upon it in this way, will be evident when the fact is recalled that the plan of the present expensive building was adopted to accommodate the museum of the Wilkes' exploring expedition, the care of which had been devolved upon the Institution by the law of Congress. But the Board of Regents, after the building was completed, decided that the keeping of this museum ought not to be a charge on the Smithson fund, and before assuming the care of it asked an appropriation, at least equal to

the cost of keeping the articles, while in the Patent Office. (
gress recognized the propriety of this position, complied with
request, and has appropriated since the transfer, annually, $4,
This sum, however, has not sufficed to defray the cost of att
ance, even during the period of low prices previous to the
without allowing for any increase in the number of articles, o
the interest of the money expended on the building.

It is highly gratifying to observe that a more liberal spiri
present exists. Congress has recently made provision, o
ample scale, for the accommodation of an Army Anatomical
seum, and for a Museum connected with the Agricultural De
ment, and it can scarcely be doubted, that on a proper present
of the subject, the same enlightened consideration which pr
ed the appropriations for these kindred objects, will also i
Congress either to appropriate the Smithsonian building to th
of a National museum, under a separate organization and en
ment, or else to make an annual grant of money, which, expe
under the direction of the Board of Regents, shall be suffic
properly to support an establishment of this kind.

The reconstruction of the building has been carried on during
past year as rapidly as the funds at command and a due reg
to the character of the work would allow. The considerati
which have governed the building committee have been to ren
the work entirely stable in regard to materials and construct
and thoroughly fire-proof, first completing such parts as were
cessary for the safety of the structure, and next those most wa
for use in the operations of the establishment.

One of the most important points to be determined during
year was the kind of roof to be adopted for the main build
and, after full inquiry, the preference was given to one, consis
of an iron frame with slate covering. The contract for the
work was made with the Phœnix Iron Company of Philadel
but owing to unexpected delays the frame was not receive
time before the setting in of frost to complete the covering
slate. The walls of the large south tower were found in a w
condition than was at first supposed, thirty feet of the height
ing to be removed and entirely rebuilt, the facing of cut s
being of new material. To secure the front towers and fu
supports for the iron beams and brick arches for the floors, a l
of brick, laid in cement, has been constructed from the botto
the top. The inner lining of the walls of the upper story o
main building, which was exposed to the fire, has also bee
tirely renewed with similar materials. The masonry of the
building is now completed, and it is expected during the nex
son to finish all the rooms except the main hall over the mu
The future use of this room, which is 200 feet long by 50 feet
has not yet been settled. It will not be wanted for the us
the Institution, and unless devoted to a National Museum o
some other purpose, it would probably remain for an indef

time, unfinished. The reconstruction of the building, exclusive of this room, will cost $150,000, and if to this be added the sum previously expended on the erection of the building, we shall have a total of $475,000, of which, at least, $400,000 might have been added to the principal, or expended in the promotion of knowledge.

The superintendence of the work is still under the direction of the architect, Mr. Adolf Cluss, and every part of the construction and all the plans have been critically examined and discussed by General Government. •

8. *Porcelain-like glass from Cryolite.*—The various products of the Cryolite industry are briefly stated in volume xxxv (1863) of this Journal. These products are manufactured on a large scale at Natrona, Pennsylvania. And in addition a glass has been made by fusing together sand and cryolite which is a very close and handsome imitation of fine porcelain.

9. *Dr. Livingstone.*—Sir Roderick Murchison in his address before the Geographical Society, cited at page 14, states his firm belief in the safety of Dr. Livingstone. The latest telegram announces that this African traveller is alive and well. Positive advices just received in London leave no doubt as to his safety.

OBITUARY.

10. Dr. JOHN RUGGLES COTTING.—Dr. Cotting died at Milledgeville, Ga., on the 18th of October. He was born in Acton, Mass., in 1784. The following sketch is from the Southern Recorder.

His first fifty years were spent in Massachusetts; his last thirty in the valley of the Oconee, in Georgia, at Milledgeville. Refined by nature and by all the good influences of Harvard and Dartmouth colleges, he perfected his excellent education by several years of professional life in Amherst College, in high schools and in the Berkshire Medical Institute; and besides this, during all these years, he was a settled Congregational minister of the Gospel. In 1835 Dr. Cotting removed South, and was first settled in Augusta, Ga., where he was engaged by some liberal, enlightened gentlemen, all or mostly cotton planters, to make a geological and agricultural survey of Burke and Richland counties. This important work, the first of its kind in Georgia, was done in the year 1836; his map and drawings were deposited in the Medical College of Georgia, at Augusta, and his report, an interesting duodecimo, with his local and geological descriptions, analysis of cotton lands, and a table of fifty-seven genera, embracing a large number, of fossils, was published and submitted to Governor Schley, who laid it before the legislature and urged them to order a similar survey of the state. They adopted his advice, appropriated $10,000 to the service, and Governor Gilmer appointed Dr. Cotting to the office of state geologist. The work was carried on for two years, when owing to financial trouble the legislature withdrew the appropriation, and the survey ceased. During its progress, Dr. Cotting collected in the eastern counties of the state, and in the extreme southwest county, Decatur, a rich herbarium of our

peculiar flora, and a cabinet of our fossils and minerals, of
scientific interest. Unfortunately for the cause of science h
lection was distributed among the colleges or otherwise di
of, and the results of his labors are lost.

11. Lord Rosse, the Astronomer, died Oct. 31, aged 67 y

IV. MISCELLANEOUS BIBLIOGRAPHY.

1. *Colton's Journal of Geography and Collateral Sc*
a record of Discovery, Exploration, and Survey, issued qu
from Colton's Geographical establishment. 16 pp. 8vo. $1
New York, Oct., 1867. Number 1.—Messrs. G. W. & C.
ton, who are well known as the publishers of Colton's Atl
other American maps, have commenced the publication of a
nal of Geography and Collateral Sciences." It is to be pul
as a record of discovery, exploration and survey. The firs
ber contains a summary of what is known in respect to
illustrated by a map of the Territory, including the nu
appertinent islands; and also the earlier portion of a pa
Prof. J. D. Dana, on "the plan of development in the Geo
History of North America," which was read before the Am
Association in 1856, and is illustrated by a map of the wo
Mercator's projection. The Journal also contains a selec
items pertaining to recent discoveries and investigations on
ent parts of the globe.

The publishers are very modest in the announcement o
plans,—but they show a good spirit, and we trust that the
receive sufficient encouragement in their undertaking to w
its continuance. If they will bring together merely the res
American researches and surveys, with carefully prepared
they will render a good service to scientific readers. Th
number is dated October, 1867; the second has not yet reac

2. *The Cambridge course of Elementary Physics.* Par
Cohesion, Adhesion, Chemical affinity, and Electricity. By
Rolfe and J. A. Gillet, Teachers in the High School, Cam
Mass. Boston, Crosby & Ainsworth, 1868. 12mo, pp. vi,
This book aims to be a collection of leading principles, rath
a mere compilation of facts. The molecular attractions, c
and adhesion, are very well treated from the modern stan
The chemical part follows in the main, the order of Ho
modern chemistry. The new notation is used, but joined to
fitting nomenclature of the old. Facts too, are rather scar
student ought to have the properties of the principal elemen
fully stated, to enable him to understand the more practic
of the section, such as the growth of plants, the manufa
sulphuric acid, soda-ash, etc. The subject of electricity is v
presented. An excellent summary of the contents of each
is given at its close, and chemical problems are introduce
needed. Greater precision of language would be desirabl
ever, in some instances; as when it is said "The partic
which a solid is resolved when it melts, and a liquid when

e called *molecules*"; and again when chemical affinity is defined
"that force which causes the elements to combine." Moreover
e equation $Na_2\Theta+H_2S\Theta_4=HNa\Theta+HNaS\Theta_4$ is hardly admis-
le. We think that the book will serve a good purpose neverthe-
s, and commend it to the attention of teachers.

3. *The Cambridge course of Elementary Physics:* Part Third,
stronomy, by W. J. Rolfe and J. A. Gillett, Teachers in the
igh School, Cambridge, Mass. 308 pp. 12mo, with numerous
ustrations. Boston, 1868. (Crosby & Ainsworth, Boston; O. S.
lt, New York.)—This little volume is intended as a popular in-
oduction to Astronomy for High Schools and Academies, and
pears to be well adapted to its purpose. The abstruse mathe-
atics of the subject are not touched upon; while the principles are
ccinctly and clearly explained and illustrated by excellent wood
ts. The cuts of the nebulæ, of the Moon's surface, and the surface
some of the planets, have hardly been excelled as wood engravings.
e volume closes with "Questions for review and examination."

4. *Akademische Denkreden*, von Dr. Carl Fr. Ph. v. Martius,
itgliede der K. Bayer. Akademie der Wissenschaften, und Secre-
r der Mathemat.-Physical. Classe. Leipzig, 1866. pp. 619.—
various times, during many years past, Dr. Von Martius has
en called upon to present to the Academy above named, bio-
aphical or memorial notices of members recently deceased, a
rk he was peculiarly fitted to perform. He has now collected
papers into the volume before us, making a valuable collection
forty-four biographical notices, some of which have appeared
ore, others not, but all have been revised or amended, where
has been deemed advisable. We have here pleasant sketches
he lives of many of the men who have been especially eminent
cience in Europe, who have died during the last thirty years or
e.

Physical Geography; by Prof. D. T. Ansted, M.A., F.R.S.,
468 pp. 12mo. Philadelphia, 1867. (J. B. Lippincott & Co.
rof. Ansted's work on Physical Geography gives an interesting
popular view of the features and physical phenomena of the
e. It is full in facts, for a work of the size, more so than
ably most teachers would desire, and less well supplied than it
nt be with comprehensive views of the arrangements of the
h's surface. The author sees no objection to the Darwinian
thesis.

Report of the Superintendent of the U. S. Coast Survey,
ing the Progress of the Survey during the year 1865. 232 pp.
with 31 large plates, m[illegible]y maps.—The health of Dr. Bache,
Superintendent of the Coast Survey was already much im-
ed, when the Report for 1865 was called for, and the work of
preparation consequently devolved on the able Assistant in
ge, J. E. Hilgard. This volume is especially rich in its maps.

Chambers's Encyclopedia, A Dictionary of Universal Knowl-
e for the People, on the basis of the latest edition of the Ger-
. Conversations Lexicon. Illustrated by wood engravings and
s. The American reprint by J. B. Lippincott & Co., of Phil-

adelphia, of this valuable and popular Encyclopedia has been issued to Part 119 inclusive, which closes volume IX, and carries the work half through the letter V.

8. *The Chemical News.*—The American reprint of the Chemical News, has now become a true transcript of the original work, and we commend it to the American public.

Proceedings of the American Association for the Advancement of Science. Fifteenth meeting, held at Buffalo, N. Y., Aug. 1866. 130 pp. 8vo. Published by Joseph Lovering, Permanent Secretary, Cambridge, 1867.

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PROCEEDINGS BOSTON SOC. NAT. HIST., vol. xi.—p. 132, On Diatomaceous mud from Pleasant Beach, Cohasset; *C. Stodder.*—p. 136, Method of stimulating union between insects of different species; *L. Trouvelot.*—p. 141, Rocks in Nature and in the Arts; *A. L. Fleury.*—p. 151, Meteorology of Cape Flattery, Washington Territory; *J. G. Swan.*—p.161, Annual Report.

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THE

AMERICAN

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[SECOND SERIES.]

ART. XVIII.—*Michael Faraday, his Life and Works;* by Professor A. DE LA RIVE.*

SCIENCE has just lost one of its most eminent and faithful representatives. Faraday died on Sunday, the 25th of August, 1867, at Hampton Court; he was born on the 24th of September, 1791, at Newington Butts, near London. In 1804, at the age of thirteen, he was apprenticed to a book binder, in whose workshop he remained eight years. So many books passed through his hands that he could not resist the temptation of opening and reading some of them. These readings, performed in the evenings after the work of the day was finished, gave him a taste for study, and in particular for that of the sciences. The *Encyclopædia Britannica* first of all introduced him to some notions of electricity; and it was afterward, from the works of Mrs. Marcet, that he derived his first knowledge of chemistry. His labors received their permanent direction from this opening; their essential objects were electricity and chemistry.

"Do not fancy," he said to me in a letter† of the 2nd of October, 1858, in which he gives me these details, "that I was a profound thinker or a precocious child; I had merely a good deal of life and imagination, and the tales of the Thousand and One Nights pleased me as much as the *Encyclopœdia Britannica.*

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* Copied from the Phil. Mag. for Dec. 1867, for which it was translated from the Bibliothèque Universelle, October 25, 1867, Arch. des Sci., pp. 131–176.

† This letter was addressed to me on the occasion of the death of Mrs. Marcet, and the notice which I was about to publish on this distinguished woman (see Bibl. Univ. nouvelle série, 1858, vol. iii.).

"But what saved me was the importance I early attached to facts. In reading Mrs. Marcet's book on chemistry, I took care to prove every assertion by the little experiments which I made as far as my means permitted; and the enjoyment which I found in thus verifying the exactitude of the facts contributed essentially to give me a taste for chemical knowledge. You may therefore easily imagine the pleasure I experienced when I subsequently made the personal acquaintance of Mrs. Marcet, and how delighted I was when my thoughts went backward to contemplate in her at once the past and the present. Whenever I presented her with a copy of my memoirs, I took care to add that I sent them to her as a testimony of my gratitude to my first instructress."

"I have the same sentiments toward the memory of your own father," adds Faraday; "for he was, I may say, the first who encouraged and sustained me, first at Geneva when I had the pleasure of seeing him there, and afterward by the correspondence which I regularly maintained with him."

Faraday here alludes to a journey in which he accompanied Davy to Geneva in 1814, and in which, during a stay which he made with his illustrious master at my father's, the latter quickly discerned the merits of the young assistant, and formed relations with him which were interrupted only by death. At the time when he travelled with Davy, Faraday was his assistant at the Royal Institution in London; and I must say that he has more than once expressed to me, both by letter and *viva voce,* his thankfulness to the eminent chemist, who had admitted him to one of his courses, and consented, after running through the notes of this course prepared by the young pupil, to take him for his assistant.

After the journey just referred to, Faraday, with the exception of rare and short absences, never again quitted the Royal Institution, where he had his laboratory and his residence. Married to a lady worthy of him, and who shared and understood all his impressions and all his sentiments, he passed a life equally peaceful and modest. He refused all the honorary distinctions which the government of his country wished to confer upon him; he contented himself with a moderate salary and with a pension of £300 sterling, which fully sufficed for his wants; and accepted nothing supplementary to this except the enjoyment, during the summer, in the latter years of his life, of a country house at Hampton Court, which the Queen of England graciously placed at his disposal.

Without children, a complete stranger to politics or to any kind of administration, except that of the Royal Institution, which he directed as he would have directed his own house, having no interest but that of science, and no ambition but that of advancing it, Faraday was of all *savants* the one most completely and exclusively devoted to the investigation of scientific truth of which the present century offers us an example.

One may easily understand what must be produced under such circumstances by a life thus wholly consecrated to science, when to a strong and rigorous intellect is joined a most brilliant imagination. Every morning Faraday went into his laboratory as the man of business goes to his office, and then tried by experiment the truth of the ideas which he had conceived overnight, as ready to give them up if experiment said *no*, as to follow out the consequences with rigorous logic if experiment answered *yes*. His every-day labor experienced no interruption, except the few hours which he devoted from time to time to the exposition in the theatre of the Royal Institution, before an audience equally numerous and select, of certain parts of physics and chemistry. Nothing can give a notion of the charm which he imparted to these improvised lectures, in which he knew how to combine animated and often eloquent language with a judgment and art in his experiments which added to the clearness and elegance of his exposition. He exerted an actual fascination upon his auditors; and when, after having initiated them into the mysteries of science, he terminated his lecture, as he was in the habit of doing, by rising into regions far above matter, space, and time, the emotion which he experienced did not fail to communicate itself to those who listened to him, and their enthusiasm had no longer any bounds.

Faraday was, in fact, thoroughly religious, and it would be a very imperfect sketch of his life which did not insist upon this peculiar feature which characterized him. His Christian convictions occupied a great place in the whole of his being; and he showed their power and sincerity by the conformity of his life to his principles. It was not in arguments derived from science that he sought the evidences of his faith; he found them in the revealed truths at which he saw that the human mind could not arrive by itself alone, even though they are in such great harmony with that which is taught by the study of nature and the marvels of creation. Faraday had long and justly perceived that scientific data, so movable and variable, cannot suffice to give to man a solid and impregnable basis for his religious convictions; but he at the same time showed by his example that the best answer which the man of science can give to those who assert that the progress of science is incompatible with these convictions, is to say to them, "And yet I am a Christian."

The sincerity of his Christianity appeared in his actions as much as in his words. The simplicity of his life, the rectitude of his character, the active benevolence which he displayed in his relations with others, gained him general esteem and affection. Always ready to render services, he could quit his laboratory when his presence elsewhere was necessary to a friend or useful to humanity. We see him putting his knowledge under contribution both for inquiries upon questions of public health or industrial applications, and to give practical advice to an artisan or examine the discovery of a *débutant* in the scientific career. Only, as I have already said, with these exceptions, he made it a rule not to allow himself to be turned aside from the labors to which he had consecrated his life by occupations of another kind, or by those pretended duties of society which waste time, abridge intellectual life (already so short), and very often leave nothing behind them but emptiness and regret. It was not that he could not be eminently sociable when necessary, or that he did not allow himself some relaxations when, fatigued with work, he needed some repose. But these were only accidental circumstances in his life, which was so exclusively devoted to his laboratory.

The scientific career of Faraday was equally fortunate and complete. Named as early as 1823 a correspondent of the Academy of Sciences of Paris, he was called in 1844 by this same Academy to occupy one of its eight foreign Associateships, after having been associated successively with all the learned bodies of Europe and America. He was by no means insensible to these scientific honors, which he accepted with genuine satisfaction, whilst he constantly refused every other kind of honorary distinction.

But it is time to commence the more important part of this notice, that which is to be devoted to the examination of the works of Faraday. Only I may perhaps be allowed, before speaking of the works themselves, to say a few words of the manner in which Faraday worked.

Is it true that the man of science who wishes to interrogate nature must set himself face to face with his apparatus, make them act to derive facts from them, and wait until these facts have appeared, in order to deduce their consequences, and all without any preconceived idea? Most certainly the philosopher who could advance such an opinion has never experimented, and in any case this method has never been that of discoverers; it was assuredly not the one adopted by Faraday.

There is a second method also which was not his, although it is truly worthy of attention, and often fertile of results. This consists in taking up known phenomena and studying them with great precision, carefully determining all the elements and numerical data, so as to deduce therefrom the laws which govern them, and often also to show the inexactitude of the laws to which they were supposed to be subjected. This method requires great previous study, great practical talent in the construction of apparatus, remarkable sagacity in the interpretation of the results furnished by experiment, and, lastly, much perseverance and patience. It is true that it leads with certainty to a result; and this is its good side; but the difficult conditions which it imposes are so many obstacles which prevent its being generally followed, except by the highest intellects.

A third method, very different from the last mentioned, is that which, quitting the beaten track, leads, as if by inspiration, to those great discoveries which open new horizons to science. This method, in order to be fertile, requires one condition—a condition, it is true, which is but rarely met with,—namely genius. Now this condition existed in Faraday. Endowed, as he himself perceived, with much imagination, he dared to advance where many others would have recoiled; his sagacity, joined to an exquisite scientific tact, by furnishing him with a presentiment of the possible, prevented him from wandering into the fantastic. Still always wishing for facts, and accepting theories with difficulty, he was nevertheless more or less directed by preconceived ideas, which, whether true or false, led him into new roads, where most frequently he found what he sought, sometimes indeed what he did not seek, but where he constantly met with some important discovery.

Such a method, if indeed it can be called one, although barren and even dangerous with mediocre minds, produced great things in Faraday's hands; thanks, as we have said, to his genius, but thanks also to that love of truth which characterized him, and which preserved him from the temptation so often experienced by every discoverer, of seeing what he wishes to see, and not seeing what he dreads.

The works which have issued from his brain, so well organized, are numerous and varied; they relate essentially, as we have already stated, to chemistry and electricity. Those on the latter subject are by far the most numerous and important; we shall therefore devote to them the greater part of this notice, after giving a summary exposition of the others.

I.

In 1816, Davy received a specimen of native caustic lime from Tuscany. He gave it to Faraday for analysis, and found that the account given was so perfect that he had it printed, and accompanied it with some observations. This success, by giving Faraday confidence in his own strength, encouraged him to attempt other original researches. He published (in 1817 and 1818) an investigation of the passage of gases through narrow tubes, from which it appeared that the velocity of the flow of elastic fluids does not depend upon their density alone, but also upon their individual nature. Various other points of chemistry and physics, besides those which had electricity and magnetism for their object, attracted his attention from time to time throughout the whole of his scientific career. Now we have a note upon the combustion of the diamond; then an investigation of the sounds produced by the combustion of gases, or by the superposition of a strongly heated iron rod upon a mass of copper at the ordinary temperature (Trevelyan's experiment); and then, again, researches upon the limit of vaporization, or upon the evaporation of mercury at low temperatures. We may notice two important memoirs—one upon the explanation of certain optical illusions produced by bodies in motion, the other describing some new acoustic figures proceeding from the vibrations of the stratum of air in contact with the surface of vibrating plates. His elegant discovery of *regelation* (that is to say, of the power possessed by two fragments of ice when brought together to become amalgamated by the fact of their simple contact at a temperature above 32° F.), followed into its consequences as it has been by Tyndall, has had a much greater influence than perhaps he ever expected. In all these notices, even the least important of them, we find an original idea, a new and striking point of view, which enables us at once to recognize Faraday. And, in connection with this, how can we omit to mention his simple and clear explanation of table-turning, and the ingenious experiment by which he so clearly shows the muscular efforts made unconsciously by the persons who, by laying their hands upon the table, cause its movement?

Let us now dwell for a few moments upon some researches of longer duration, the publication of which preceded, and also in great part accompanied, his great works on electricity.

In 1820 Faraday described two new compounds of chlorine and carbon. One of them is solid, transparent, and colorless; it crystallizes in little prisms and in laminæ, and is obtained by exposing to the direct action of the sun bicarbonated hydrogen gas with a large proportion of chlorine. The other contains less chlorine ; it is liquid and colorless, possesses great density, and is prepared by passing the former through an incandescent tube, from which chlorine is set free. The discovery of these two compounds filled up an important gap in the history of chemistry.

Subsequently (in 1825), by the compression of the gas obtained from coal, Faraday obtained a new compound, which, no less interesting than the preceding from a scientific point of view, had besides a great industrial importance. This was a bicarburet of hydrogen in a liquid state, which was found to be a mixture of several compounds endowed with various degrees of volatility, and which could be separated by distillation. Every one knows the advantage, in the production of colors, derived from this by the illustrious chemist Hofmann, when he extracted aniline from it.

The discovery of this bicarburet of hydrogen was only an incident in the researches which Faraday had undertaken in 1823, upon the condensation of gases into liquids. His mode of operation in this investigation consisted in placing, in one extremity of a recurved tube closed at both ends, the necessary ingredients for the production of the gas, and plunging the other extremity in a freezing mixture. The gas, evolved in a closed space, speedily condensed into a liquid state in the refrigerated extremity of the tube. In this way chlorine, sulphurous acid, sulphuretted hydrogen, carbonic acid, protoxyd of nitrogen, cyanogen, ammonia, and hydrochloric acid were successively reduced to a liquid state. With the exception of chlorine, all these liquefied gases were colorless and perfectly transparent; and all of them had a refractive power superior to that of water. The attempts made to reduce the other gases, especially hydrogen, oxygen, and nitrogen, to a liquid state were fruitless. Twenty years later (in 1844) Faraday resumed these experiments by directly condensing the gases by mechanical processes in very strong and hermetically sealed tubes, refrigerating them by means of the mixture of ether with solid carbonic acid produced by Thilorier's method. The condensation could be brought to fifty atmospheres, and the lowering of temperature to −166° F., or 110° C. below 0°. In this way Faraday succeeded in liquefying, besides the gases which I have already mentioned, olefiant gas, phosphuretted hydrogen, and arseniuretted hydrogen, as also fluosilicic acid; but he did not succeed in solidifying them. On the other hand, by applying his new process to the gases which he had previously liquefied, he brought them not only to a liquid state, but even to that of transparent and crystalline solids; hydrochloric gas alone of these latter would not become solid, whilst hydriodic and hydrobromic gas were successively liquefied and solidified.

It is easy to understand all the importance of an investigation the result of which was to modify completely, the received ideas as to the constitution of the permanent gases by causing them to enter into the category of simple vapors; this was to introduce into molecular physics a new and important notion, the consequences of which have gradually unfolded themselves.

It is also to a question of molecular physics that we must refer the memoir on the relations of gold and the other metals to light, published by Faraday in 1857. Among other interesting facts that this memoir contains, we shall cite that of a leaf of beaten gold, which, when placed upon a plate of glass, becomes perfectly transparent and colorless when it is brought to a high temperature, and which, when seen by transmitted light, resumes its green color when subjected to strong pressure. A great number of experiments upon the pulverulent deposits of various metals obtained by electrical discharges transmitted through very fine wires, led to remarkable results as to the variations of color arising from change in the molecular state of the same body. We also find in this memoir a detailed investigation of the various colors presented by different solutions of gold, and especially of the fine ruby-red tinge obtained by the solution of a quantity of gold which, if agglomerated into a single mass, would not occupy the seven-hundred-thousandth part of the volume of water which it colors. It is not necessary to dwell upon the interest presented by researches having for their object the study of the influence, still so imperfectly known, of the molecular structure of bodies upon their relations to light, and especially upon their transparency.

Among the numerous works of Faraday relating to the applications of science to the arts, we shall confine ourselves to citing his researches upon the manufacture of steel, and of glass for optical purposes, these being the most important.

It was by the analysis of the Indian steel called *wootz* that he was led, in concert with Stodart, to compose an alloy which had all the properties of this, by combining aluminium with iron and carbon. In a letter addressed in 1820 to Professor De la Rive,* he relates all the attempts made by his collaborateur and himself during two years of persevering labor, to discover the most satisfactory alloys. He indicates, as one of the best, that of rhodium and steel, and, as presenting curious peculiarities, that of steel and silver; this last alloy does not become a true combination unless the silver only forms $\frac{1}{500}$ part of it. Platinum, on the contrary, combines in all proportions with steel, but it does not furnish so good an alloy as rhodium and silver for the construction of cutting-instruments.

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* See Bibl. Univ. (1820), vol. xiv, p. 209.

Although interesting in many respects, the results which Faraday obtained in his great investigation of the alloys of steel were not proportionate in their importance to the time and trouble which they cost him. We may say the same of the laborious researches upon the manufacture of glass for optical purposes, which he made a few years afterward (in 1829). It was upon the initiative taken in 1824 by the Royal Society of London, which named a committee for the study of the improvement of glass, with a view to its optical use, that Faraday was called upon to occupy himself with it. Whilst he pursued the chemical part of these investigations, Dollond worked up the glass, and Herschel subjected it to the test of experiment. At the end of long and difficult experiments, Faraday ascertained that the greatest difficulty in the way of the fabrication of a good flint glass (that is to say, a very refractive glass) was the presence of streaks and striæ proceeding from a want of homogenity, due, in its turn, to differences of composition between the contiguous portions of the same glass. The employment of oxyd of lead in the composition of flint glass was the cause of this defectiveness, which could not be avoided even by making use of the most efficacious means of rendering the mixture perfect while in a state of fusion. Among the combinations tried, that of borate of lead and silica furnished a glass endowed with optical properties still more strongly marked than those of flint glass, and at the same time presenting a very uniform structure. This glass, which, on account of its great density (double that of flint glass), has been named heavy glass, is found unfortunately to have a slight yellowish coloration which renders it unfit for optical purposes; but the labor which Faraday devoted to its fabrication has not been lost; for, as we shall see hereafter, this same glass, in the hands of the talented experimenter, became the instrument of one of his most beautiful discoveries.

In the long and curious memoir which he published upon the fabrication of optical glass, Faraday gives a minute description of all the processes employed by him, of the construction of furnaces, selection of crucibles, means of heating, various artifices, such as the injection of platinum in powder into the fused glass to cause the disappearance of bubbles, &c. It is a genuine instruction in chemical manipulation, and, as it were, a complement to his Treatise on this subject, which was published in 1827, and has since gone through three editions. Only those who are called upon to experiment in the domains of physics and chemistry can appreciate the immense service which this treatise has rendered to them, by teaching them a multitude of processes of detail so valuable for them to know, and of which a description was previously nowhere to be found, so that every one was obliged to undergo an apprenticeship to them on his own account. It was necessary that a *savant* who for so many years had been struggling with the difficulties of experimentation, and who had been able to surmount them in so ingenious a manner, should give himself the trouble to describe the means which he had employed, so that his experience might be of service to others. Faraday was this *savant,* and his object was completely attained.

Here, perhaps, before proceeding to another set of subjects, we ought to speak of certain of Faraday's theoretical ideas relating to general physics, and more especially to the nature of the forces, and their correlation to each other and to the essence of matter; but we prefer not to discuss the opinions emitted by him upon these questions until after the exposition of his works on electricity and magnetism. We must, however, at once admit that his views on these matters are very contestable, and that, if they inspired him to make experimental researches of the highest interest, this is a proof that, in the hands of a man of genius even a bad theory may be the origin of the most beautiful discoveries.

II.

I pass now to the examination of those works of Faraday which relate to electricity and magnetism. It is not without embarrassment that I approach this examination; for these researches are so numerous that it would be necessary to extend this notice beyond all bounds in order to give only a simple analysis of them; and they are at the same time so varied, that it is impossible to explain them in the chronological order of their publication without confusion being the result. Thus, for example, the researches on induction are interrupted by others on electrochemical decomposition, to be afterward resumed and completed. Each memoir certainly forms a complete whole; but one memoir is most frequently followed by another, the subject of which is quite different. It seems as if the author, after having treated one question, found it necessary to recollect himself before resuming it, and to divert his mind from it, so to speak, by taking up some other kind of work.

It has therefore appeared to me that the best thing for me to do, was to group all these various works under a few distinct heads, so as to be able to give their essence without requiring to enter into too many details. The first would include all the researches relating to electrochemistry; the second, those which have for their object induction, whether electrodynamic or electrostatic; and the third, the phenomena relating to the action of magnetism and dynamic electricity upon light and upon natural bodies in general. It is true that there are some works which elude this classification, as they will not enter into any one of our three divisions. But these are less important works, and such as were produced as occasions offered; that is to say, they are the fruit of some particular circumstances which attracted Faraday's attention to some special point. Such is, for example, the memoir which has for its object, the investigation of the electrical properties of the *Gymnotus*,—and that devoted to the evolution of electricity by the friction exerted against solid bodies by the globules of water or other substances carried up by vapor—experiments undertaken in consequence of the invention of Armstrong's machine. Lastly, there are others which only contain the more or less indirect consequences of the fundamental discoveries, which will be explained in one of the three subdivisions under which we have grouped them. We shall not dwell upon any of these, thinking that we may give a more exact and complete idea of all the progress which Faraday caused the science of electricity and magnetism to make by confining ourselves to pointing out in some detail the most prominent parts of his researches upon these subjects.

Faraday commenced with chemistry in his scientific career; it is therefore not surprising that he approached electricity by the study of electrochemistry. It was, moreover, toward electrochemistry that his attention must have been first directed in that laboratory of the Royal Institution which had witnessed the magnificent discoveries of Davy in chemical decompositions effected by the pile, and especially in the production of the alkaline metals. In taking up this subject, Faraday only followed the traditions left to him by his predecessor.

His researches upon the electrical conductibility of bodies constitute a first step in this path. The business was to ascertain whether, as was previously supposed, the presence of water is necessary to render solid bodies conductors, and whether solid non-metallic (and consequently compound) bodies can conduct electricity without being decomposed. Commencing with water, which is an insulator when solid and a good conductor in the liquid state, Faraday shows that a great number of compound substances are in the same case. Such are the many oxyds, some chlorids and iodids, and a multitude of salts, which do not conduct electricity in the solid state, but, without any intermixture of water, become excellent conductors when liquefied by heat, and are not decomposed by electricity with separation of their elements in the same way as aqueous solutions. To the list of these compounds Faraday adds that of those substances, either simple, like sulphur and phosphorus, or compound, such as the periodids and perchlorids of tin, and many others, which continue isolators when fused as well as in the solid state. In this first investigation, notwithstanding a great number of experiments in which he employed the influence of heat and of electricity of high tension in the study of the conductive power of solid bodies, he did not succeed in determining very accurately the conditions of electrical conductibility; he only ascertained that, with one exception, which he justly regards as only apparent, there is not a solid body which, on becoming conductive by its passage to a liquid state, is not decomposed by the electrical current. We may add, so as not to return to the subject, that Faraday sometimes had doubts upon this point, and he even thought that water could conduct electricity without being decomposed. Now experiment shows that in all cases, even those which appear most favorable to this opinion, electricity cannot be transmitted under any form through a compound liquid body, without this body undergoing electrochemical decomposition.

As to the causes of conductibility, they are still far from being known; when we see bodies, such as the gases, becoming conductors when greatly rarefied, whilst under the ordinary pressure they are perfect insulators, we are compelled to come to the conclusion that the impossibility that we find of explaining this difference, as well as so many others presented in this respect by solid and liquid bodies, is due to the fact that we have not yet a correct notion of the molecular constitution of bodies. Perhaps the recent theories of several physicists, particularly that of Clausius, who regards the particles of bodies as being in a constant state of movement, may succeed in elucidating this subject, which is still so mysterious. Faraday himself had fully foreseen this relation between electrical conductibility and the ideas which we may form as to the nature of matter. In a remarkable article published in 1844 he showed, upon an experimental basis, that, in the theory according to which a body is regarded as consisting of atoms possessing weight separated from each other by larger or smaller intermolecular intervals, there are a multitude of facts, some of which can only be explained by assuming that the atoms are the conductors and the molecular space an insulator, and the others by supposing that the intermolecular space is the conductor, and the atoms insulators—a contradiction which is inadmissible. He concluded from this that we must imagine matter to be continuous, or rather imagine the atoms to be simply centers of force, and consequently replace the atomistic by the dynamical theory. We shall often find traces of these ideas in the subsequent works of Faraday; for ourselves we cannot take this view. We are convinced that it is not by denying the existence of matter, properly so called, and admitting only that of forces, that we shall succeed in solving the difficulties under consideration and many others, but rather, following the example of Clausius and others, by modifying the ideas hitherto accepted as to the mode of constitution of bodies and replacing them by others more in accordance with recent discoveries.

But we must return to electrochemistry. I have already said that Faraday first occupied himself with chemical decompositions effected by the electrical current. He commences by effecting the decomposition of water and of solutions by means of a jet of ordinary electricity, rendered as continuous as possible by leaving a stratum of air interposed between the metallic points which convey and carry off the electricity from a machine, and a strip of moistened paper which this electricity traverses; he observes that the deposition of the elements separated from the decomposed liquid takes place against the surface of the air which is in contact with the paper. Then, investigating the decompositions effected by the pile, he examines the various explanations which have been given of this phenomenon, and concludes that it is much rather a chemical phenomenon than a truly electrical one. In other words, it is a peculiar form of affinity which, under the influence of electricity is exerted between the neighboring molecules, so that the decomposition is the easier in proportion as the affinity is stronger. He shows that the transfer of the elements can only take place between bodies, the constituent parts of which have an affinity for each other; and if these elements separate in a free state against the surface of the metallic poles of the pile, this is because they cannot combine with the substance of these poles; for whenever this combination is possible, they are no longer set free. Water in some cases, air in others, as we have already seen, may serve as poles just as well as solid bodies. Faraday justly rejects the old idea of certain physicists who attributed electrochemical decompositions to the ordinary electrical attractions and repulsions exerted upon the elements of a conductive liquid by the voltaic poles immersed in it. The metallic wires, or other conductors, which transmit electricity into a liquid, are merely, according to him, the roads by which the electric current passes into the liquid; therefore, to exclude any idea of electrical tension which is more or less implied in the name *pole*, Faraday proposed to substitute for the denomination *poles* that of *electrodes*. He likewise applied the term *electrolysis* to the chemical decomposition effected by electricity, reserving that of *analysis* for the ordinary chemical decompositions in which electricity does not assist. Lastly, he gives the name of *electrolytes* to those compound bodies which are capable of being decomposed by the electric current.

After this preliminary and general study of the subject, Faraday enumerates the results which he obtained by submitting to electrochemical decomposition a very great number of compounds, some of them simple acids or simple bases, others saline combinations. He dwells particularly on the secondary effects often manifested in these decompositions, especially in the case of aqueous solutions, in which decomposition of the water and of the substance dissolved takes place at the same time. But the essential point of his researches is the law at which he arrived as to the definite nature of electrochemical decomposition. He demonstrates, relying solely upon experiment, that the quantity of chemical action exerted by an electrical current is proportionate to the quantity of electricity constituting this current, and, further, that the same quantity of electricity, or the same current, decomposes chemically equivalent quantities of all the compound bodies through which it is passed. Thus, if we place one after the other, in the circuit of a voltaic pile, several pieces of apparatus arranged for the decomposition of water and for collecting the gaseous products of this decomposition, we find that in all, even when the degree of acidity of the water and the form and size of the electrodes are different in each, the same current traversing them for a given time produces the same quantity of gas, and consequently decomposes the same quantity of water. The quantity of water decomposed in a given time, appreciated by the quantity of gas evolved, is therefore the exact measure of the quantity of electricity which has produced this effect. Hence, like Faraday, we give the name of *voltameter* to the very simple apparatus which holds acidulated water destined to be decomposed by the current, and by means of which the volume of gases set free by this current in a given time may be exactly measured.

The second principle, that the same quantity of electricity decomposes chemically equivalent quantities of all compound bodies, was demonstrated by Faraday by placing several different electrolytes one after the other in the same circuit, as, for example, acidulated water in a voltameter, and protochlorid of tin and chlorid of lead in a state of fusion; and he obtains quantities of tin, lead, chlorine, hydrogen and oxygen which are chemically equivalent. Then, rising from the effect to the cause, he comes to the conclusion that there is a perfect equality between the electricity which decomposes a body and that which is generated by the chemical action which produces the direct decomposition of an equal quantity of the same, or of a chemically equivalent quantity of some other body. He is thus led to pay attention to the theory of the pile, and to recognize that the power of this apparatus originates in chemical action, and not in the contact of two heterogeneous metals—a contact which is not necessary either to produce a spark or to cause a chemical decomposition.

He establishes in the first place, that, either to effect a decomposition or to produce a spark, a plate of zinc immersed in acidulated water is sufficient without its being necessary to bring the zinc into contact with any other metal. He shows that in every pile the presence of an electrŏlyte (that is to say, a liquid susceptible of being decomposed) is indispensable for the evolution of electricity. Then, distinguishing in the electricity generated the intensity (or the tension) and the quantity, he studies the circumstances, depending either on the nature of the chemical action or the number of voltaic pairs associated, which exert an influence on these two characters of the current. In a word, he establishes such a correlation between that which occurs in the interior of a pile and that which takes place in the electrolyte interposed between the poles of this pile, that it is impossible not to admit (with him) that electrolytic decomposition is nothing but a form of chemical affinity transferred from the pile into the electrolyte decomposed.

Wishing to obtain an idea of the quantity of electricity which is associated with the particles of which matter is composed, he endeavors to estimate that which is necessary for the decomposition of a grain of water, regarding it, as he is justified in doing, as equivalent to that produced by the direct chemical action (of the acidulated water upon the zinc) which decomposes this grain of water. He arrives at this incredible result—namely, that this quantity of electricity, appreciated by the heat evolved by it in traversing a fine platinum wire, is superior to that manifested in 800,000 discharges of a battery of Leyden jars, charged by thirty turns of a powerful plate-machine, and consequently equivalent to that constituting a violent flash of lightning.

The researches of which I have been speaking were made in 1833, 1834, and 1835. I had previously paid attention to the same questions, and had arrived by somewhat different methods at the same conclusion with Faraday—namely, that it is in chemical action that resides the origin of the evolution of electricity in the voltaic pile. Faraday frequently alludes to my investigations in a very kind manner; and subsequently (in 1840) he wrote me a letter in which he said that, being a thorough adherent of the chemical theory, he had just attacked the question directly, as I had already done, by demonstrating that contact alone, if not accompanied by chemical action, is not a source of electricity. The memoir in which he probes this question to the bottom is the last which he devoted to this department of electricity. In it, by means of a multitude of ingenious experiments, he demonstrates that the presence of an electrolyte (that is to say, of a liquid which is at once a compound and a conductor of electricity) is indispensable for the production of electricity in a voltaic couple; he varies his experiments in a thousand ways, sometimes by exhausting the number of chemical compounds employed as electrolytes, sometimes by the intervention of temperature or of other agents; and he concludes by showing by general considerations the improbability of the existence of a force of contact.

We may say that this last work, a precious supplement to the preceding ones, has rendered perfectly evident the truth of the chemical theory. This theory, foreseen by Wollaston and Fabroni, but opposed by most of the physicists of the early part of the present century, had found a powerful argument in its favor in the beautiful experiments of the elder Becquerel upon the electricity developed by chemical actions. It was then (from 1825 to 1835) that, profiting by these experiments, and seeking, on my own part, to make others of the same kind although in a slightly different direction, I published several memoirs to support and render more precise the chemical theory of the voltaic pile. But I cannot but admit that we are indebted to Faraday for having based this theory upon irrefutable proofs, not only by the great number and variety of his researches, but especially by his beautiful discovery of the definite decomposing action of the electric current—a discovery which established between the external chemical action of the voltaic pile and the chemical action which takes place in the interior of this apparatus, a relation so intimate that it is impossible not to see in the latter the cause of the former.

III.

In 1831 Faraday discovered electrical induction; it is the most important, although perhaps not the most brilliant of his discoveries. Ten years before (in 1821) he had observed a perfectly new phenomenon in the science of electrodynamics,—that science which issued complete, as we may say, from the brain of Ampère, after Œrsted's discovery. Struck by the experiments of the great French physicist upon the mutual attractions and repulsions of electrical currents and magnets, Faraday was led, by theoretical ideas which were rather disputable and not very conformable to the principles of mechanics, to assume that an electric current must turn round the pole of a magnet with a continuous movement, and reciprocally that the pole of a magnet must in like manner turn round an electric current. He verified this double result by experiment; and Ampère soon showed its accordance with his theory, adding to it other facts of the same nature. It is not the less true that the discovery of a continuous movement of rotation due to the combined action of a magnet and an electric current was quite unforeseen, and at the same time very important; for up to that time there was no example of any such action in physics. It was a first step in the course which was to lead to the finding of a relation between mechanical movement and the molecular forces.

Arago (in 1824) was the first who directly established this relation, by his beautiful discovery of magnetism by rotation; for he showed that simple mechanical movement could render a body, in itself non-magnetic, capable of acting upon the magnet. Faraday advanced still further in 1831, by discovering that it was sufficient to bring toward, or remove from, a metallic wire forming a closed circuit another parallel wire traversed by an electric current, or simply a magnet, in order to develop in the former wire an electric current. He discovered induction—that phenomenon which so many others had sought in vain, although suspecting its existence, but which he alone had succeeded in producing.

Let us dwell for a moment upon his fundamental experiment. Two metal wires covered with silk are rolled together round a cylinder of glass or wood; the two wires are thus isolated, and have all their spires approximate and parallel. An electric current is passed into one of these wires; immediately a current is manifested in an opposite direction in the neighboring wire, the extremities of which are united by a galvanometer; but this current only lasts for a moment. The current passing through the first wire is interrupted; immediately another current is developed in the second wire, which is momentary, as in the former case, but directed in the same way as the producing current, instead of in the contrary direction. The momentariness of these two currents, and the fact of their alternately opposite directions, constitute the two important characters of this new mode of production of electricity.

Faraday did not stop at this. Starting from Ampère's idea that a magnet is only an assemblage of electric currents arranged round an axis in a manner very analogous to the circulation of an electric current through a metallic wire rolled into a coil, he tried the replacement, in his fundamental experiment, of the wire traversed by the current by a simple magnet. For this purpose he twisted a single wire instead of two into a coil round a glass or wooden tube; then he introduced a magnet into this tube, and ascertained that at this moment a momentary current is developed in the coil of wire, and that a second, equally momentary but in an opposite direction, is developed at the moment when the magnet is withdrawn. Here, therefore, was realized that production of electricity by magnetism which Faraday had long been seeking, convinced, as he was, that, as electricity produces magnetism, magnetism in its turn must produce electricity.

Is it necessary to follow Faraday in the multiplied experiments by which he demonstrates that the electricity developed by induction possesses all the properties of voltaic electricity, and of the ordinary electricity produced by machines—that it heats fine metallic wires, gives shocks, and even produces the spark? To produce an electric spark by means of the action of a simple magnet, is one of those striking facts which give to the discovery leading to such a result a popularity, if I may venture so to express myself, which is reflected upon its author.

Faraday soon showed that terrestrial magnetism, like that of a magnet, can develop electric currents by induction in a metallic wire rolled into a coil or circle, and actuated by a movement of oscillation in a plane perpendicular to that of the magnetic meridian. He found that it was not even necessary to employ metallic wires to ascertain the influence of the terrestrial magnetism upon the production of induced currents, but that it sufficed to set a metallic disk (of copper for example) in rotation in a plane perpendicular to the direction of the inclination-needle to find that it is traversed by electric currents passing from the center to the circumference, or from the circumference to the center, according to the direction of the rotation. Still more readily does the vicinity of a magnet to a similar disk set in rotation in any plane under the influence of this magnet develop in it induced currents, the presence of which, directly ascertained, explains in a perfectly satisfactory manner the phenomena of magnetism by rotation discovered by Arago.

These currents, although difficult to perceive, must nevertheless possess considerable power, since they can drag a rather heavy magnet by the action which they exert upon it. It is probable that this power is due less to their individual intensity than to their number, which appears to be very considerable. We may cite two examples which prove in a striking manner the energy which this mode of production of induced currents may acquire. The first is furnished by a curious experiment of Faraday's, in which, on causing a cubical mass of copper suspended by a thread between the poles of an unmagnetized electromagnet to turn upon itself, he saw this mass stop suddenly the moment he magnetized the electromagnet, in consequence

e magnetic action exerted by the currents which induction
et up in the copper. We find the second example in the
bserved by Foucault, of the sudden stoppage which is like-
experienced by a thick disk of copper set in rotation between
oles of an electromagnet the moment the latter is magnet-
This stoppage is such that it can only be surmounted by
siderable effort, and the disk itself becomes very strongly
d if the rotation be continued in spite of the resistance it
s with. In order that such a heating effect should be pro-
d in a mass of such considerable size, and that we should
rience an attractive action so strong on the part of the
romagnet, the induced currents thus produced must be of
great power—a power which they owe essentially to the
sive rapidity of the movement generating them.

hall not follow Faraday through all his works upon induc-
which accompanied his fundamental discovery. I shall
refer to the fact that in 1834 he discovered a new impor-
fact—namely, the production of an induced current in the
wire that conducted the inductive current, and which
place at first at the moment when the latter current be-
to circulate, and then at that when it ceases passing. If
wire is rolled in a coil round a cylinder of soft iron; the
t produced acquires great intensity by the fact of the al-
ate magnetization and demagnetization of the iron which
mpanies the passage and interruption of the current in the
We all know the advantage that has been taken of this
bination in the construction of very powerful apparatus.
also know how, from one improvement to another, we have
to find in induction, and consequently in the simple
anical movement which gives birth to it, the most simple
economical principle for obtaining electricity, especially
regard to its application to therapeutics and illumination.

he discovery of electrodynamical induction (that is to say,
roduction of a current by the influence of an exterior cur-
) led Faraday to examine more closely than had previously
done into the phenomenon of statical induction—that is to
the development at a distance of tension-electricity in an
ted conductor by the influence of an electrized body. He
rtained, what no one had previously suspected, that the
re of the body interposed between the source of electricity
the conductor submitted to the action of this source had
eat influence upon the effect produced—that, of the vari-
bodies, some facilitated the development of electricity at
stance, whilst others completely stopped it. He named the
er *dielectrics;* and he proved that these dielectrics, which
essentially resins, sulphur, shellac, oils of turpentine and

naphtha, &c., enjoy this property of transmitting electricity by influence in different degrees, whilst there is not in this respect any difference between the gases, which have the same dielectric power whatever their nature or their density may be. On the other hand, none of the metals are dielectric; they are subject to the electrical influence but do not transmit it.

From the investigation which we have just summarized, Faraday drew the conclusion that induction does not take place at a distance, but that it is affected by the intermediation of the particles interposed between the inductor and the inducted body. He assumed that these particles are polarized one after the other, which M. Matteucci afterward demonstrated directly by experiment; that consequently the mode of propagation of electricity is the same in insulating as in conducting bodies; and that the various substances only differ from each other by the greater or less facility or rapidity with which this polarization, necessary for the transmission of electricity, takes place in them. Then, passing from this to analysis of the different modes in which electrical discharges take place, some obscure, others luminous, some electrolytic (that is to say, accompanied by the chemical decomposition of the conducting body), others disruptive (that is to say, effected by the mechanical disjunction of the particles of the interposed substance), he applied himself more particularly to the study of the various forms displayed by the electric spark in more or less rarefied gases. I should never have done if I were to attempt to explain all the experiments which he made to elucidate these different points and to arrive at an idea of the actual nature of the electric current. The identity of the current, whatever may be its origin,—that its production is due to polar forces which may exert a transverse action, as is the case in electrodynamical phenomena,—that these polar forces emanate from contiguous particles; such are the principles which Faraday endeavored to establish as the consequences of his experimental researches, at the same time that he rejected the idea of actions at a distance, referring all electrical manifestations to the presence of a ponderable matter.

Whether or not we completely admit all Faraday's ideas, it is impossible not to acknowledge the immense advance which he caused the theories of electricity to make, either by demonstrating by experiment the falsity of certain conceptions generally accepted up to his time, or by opening up perfectly new points of view as to the actual nature of electrical phenomena. We have just had the proof of this in the consequences to which he was led by his investigations on statical induction. His discoveries in electrodynamical induction have had still more important consequences, by introducing the notion of mechanical movement into the essence of electrical movement, and thus enabling Weber to combine, in an equally ingenious and satisfactory manner, the mechanical phenomena of electrodynamics, discovered by Ampère, with the electrical phenomena due to mechanical movement, discovered by Faraday.

Ampère and Faraday,—two names which will always be united by the intimate relation of their works to the history of the science of electricity, in which they have opened such new and vast horizons; and yet minds as dissimilar in their mode of proceeding as similar in the power of their genius. Both eminently endowed with that faculty of divination which generates great discoveries, but one of them, Faraday, arriving at them by impression, by a kind of instinct which never deceived him,—the other, Ampère, advancing with a more certain step, having as his instrument those calculations which he handled with such remarkable ability, and thus arriving at results which he hardly required experiment to confirm, so certain was he that this would not contradict him.

IV.

I now pass to the last great series of Faraday's works. I have said, and, I think, proved, that induction was the most important of his discoveries; I must now say that the action of magnetism and electricity upon light was the most brilliant. Often the attempt had been made to see whether magnetism and electricity exerted any direct influence upon light; but these attempts had always failed. Investigators had operated upon luminous rays traveling in the air or in liquids, and endeavored to act upon them, sometimes by strong magnets, sometimes by electric currents or by statical electricity; but these attempts had led to nothing, absolutely nothing. All these negative investigations have never been published, but they have nevertheless been made.

Guided by theoretical considerations upon the mutual correlation of the forces of nature, Faraday, after many fruitless attempts, succeeded in finding the connection which exists between light and the magnetic and electric forces. Instead of taking an ordinary ray, he operated with a polarized ray; instead of acting directly upon this ray by means of a magnet, he submits it to the influence of magnetism whilst it is traversing a glass prism in the direction of its length. This prism, terminated by two square and parallel bases, the surfaces of which are well polished, and which are those by which the polarized ray penetrates and issues from the prism, is placed between the poles of an electromagnet in such a manner that its length, and, consequently, the direction of the transmitted ray are parallel to the line joining the magnetic poles. Lastly, the polarized ray on issuing from the glass prism only reaches the eye after passing through a Nicol's prism which serves as an analyzer. It is also by traversing a Nicol's prism before penetrating into the glass prism that the ray of light is polarized; but this may be effected in any other manner.

It is well known that by turning the analyzing prism to a certain angle the polarized ray is extinguished, in such a manner that the brilliant spot is replaced by a black spot. If, after this operation has been effected, a strong electric current is passed through the wire surrounding the electromagnet, the black spot disappears and the bright one again makes its appearance. Then by turning the analyzing prism a little further in the same direction, the luminous ray is again extinguished, but this extinction ceases as soon as the magnetic action is suppressed by the interruption of the current which magnetized the electromagnet. The action of magnetism therefore consists simply in causing the plane of polarization to turn by a certain angle, and to give artificially to the glass, while it is under the magnetic influence, a property which certain substances, such as quartz and essence of turpentine, possess naturally.

Any transparent substance, except gases, may serve, although in different degrees, as the *medium* for magnetism to act upon the polarized ray. But that by means of which this influence is best manifested is the yellowish heavy glass (borosilicate of lead) which Faraday obtained in his experimental researches upon the fabrication of glass for optical purposes. He happened to have at hand several specimens of this glass; and it was by using one of these for performing the experiment just described that he discovered the magnetic rotation of the plane of polarization, a phenomenon which would probably have escaped him if he had made use of ordinary glass at first starting. Thus the long and painful labors to which he had formerly devoted himself without any great success, in order to discover a glass fitted for the fabrication of lenses, were not lost to science, since they facilitated his enriching it with one of his finest discoveries.

Let us now study the new phenomenon a little more closely, so as better to show all its importance. Some substances we have said, naturally possess the property of causing the plane of polarization of a polarized ray traversing them to rotate through a larger or smaller angle; some cause it to turn to the right, and others to the left of the observer. The discovery of Faraday was that the influence of magnetism or of electric currents develop this same property in nearly all transparent substances, but with this difference, that the direction of rotation of the plane of polarization depends only upon the position of the magnetic poles, or the direction of the currents with relation to the transparent substance. The law is that if the north pole of the electromagnet is placed on the same side as the observer who receives the ray into his eye, and consequently the south pole on the side by which the polarized ray enters into the substance, the rotation of the plane of polarization takes place, to the observer, from left to right. It takes place from right to left if the direction of the current, and consequently that of the magnetization, be changed. The action of the magnet may be replaced by that of a coil in the axis of which the transparent substance is placed. In this case, again, the rotation of the plane of polarization is very well observed when a rather strong current is transmitted through the wire of the coil; and the direction of the rotation is always the same as that of the current.

Thus, whilst in substances naturally endowed with circular polarization the rotation of the plane of polarization always takes place, according to the nature of the substance, either to the right or left of the observer, in Faraday's experiment the direction of this rotation only depends upon the direction of electric currents or the relative position of the magnetic poles, since it is completely independent of the position of the observer. These two kinds of action are therefore not identical, and we cannot say that by the influence of the magnet or of electricity we produce in all transparent bodies exactly the same property that certain substances naturally possess. Faraday well shows this difference by an experiment which consists in producing by an ingenious artifice the internal reflection of the polarized ray upon the extreme surfaces of the prism; this may be done once or several times before the ray is allowed to escape, and doubles, triples, or quadruples the angle of rotation of the plane of polarization, according as the ray is reflected once, twice, or three times. But when, instead of the magnetic, we have to do with the natural rotatory polarization, the result is quite different, the return of the reflected ray neutralizing the effect which the direct ray had undergone while traveling in an opposite direction. In this case the angle of rotation of the plane of polarization reflected twice, and which consequently has three times traversed the transparent substance, is no greater than that of a ray which has only traversed it once.

The general phenomenon so unexpectedly discovered by Faraday has hitherto remained unexplained, notwithstanding many investigations, and especially the persevering and remarkable researches of Mr. Verdet.

It has not even been possible to connect it with some other property of bodies, although each substance has its specific magnetic rotatory power. Faraday, however, drew from it a general consequence which led him to another discovery, namely, that magnetism acts upon all bodies, since all transparent bodies may be modified under its influence sufficiently to acquire, in different degrees indeed, a power which they do not possess of themselves. The discovery to which I have just allluded is that as the magnet acts by attraction upon magnetic bodies, it acts also by repulsion upon all other bodies in nature. From this it results that whilst a rod of iron, or of some other magnetic substance, suspended between the poles of an electromagnet, places itself *axially* (that is to say, parallel to the line which joins the poles), a prism of heavy glass (the same, for example, which served for the experiments on light) places itself equatorially (that is to say, transversely to this line). A rod of bismuth is in the same case; and this metal and heavy glass are the substances on which this repulsive action of the magnet is most distinctly exerted; but all bodies in nature which are not magnetic (and these are by far the most numerous) present the same property, although in various degrees. In this way Faraday comes to class all bodies under two heads:—those which are magnetic, or *paramagnetic*, as he calls them, such as iron, nickel, &c.; and those which are *diamagnetic*, such as bismuth, antimony, heavy glass, &c. The character of the former is to be attracted by the magnet, that of the latter to be repelled by it. It is true that this repulsion, to become sensible, requires an enormous magnetic power, even in the case of bodies of which the diamagnetism is most strongly marked, whilst a very weak magnet is sufficient to betray its action upon the magnetic bodies, such as iron, steel, nickel, &c.

It therefore required very powerful means, such as Faraday employed, for the discovery of diamagnetism. Nevertheless a distinguished amateur in science, Mr. Lebaillif of Paris, had shown, as early as 1828, that a fragment of bismuth or antimony very evidently repels a delicately suspended magnetized needle when brought as near as possible to one of the poles of the needle but without touching it. Mr. Faraday was ignorant of this circumstance when he published his first work on diamagnetism. I immediately informed him of it, at the same time indicating the journal in which I had published Mr. Lebaillif's experiment, which I had witnessed at the time. He accepted my reclamation in the most amicable manner, and at once, with his usual good faith, recognized the priority of Mr. Lebaillif with regard to bismuth and antimony.

In the numerous researches which Faraday devoted (from 1845 to 1855) to diamagnetism and at the same time to magnetism, there are some important points which I must indicate. He discovered the remarkable influence exerted upon this kind of properties by the molecular constitution of bodies, and especially by crystallization. He showed, for example, that a crystallized lamina of bismuth or antimony can place itself axially between the poles of an electromagnet like a magnetic body, as well as equatorially, and that the position which it takes depends on the manner in which it is suspended relatively to the direction of its cleavage. He endeavored to investigate the force which comes into play in facts of this order, which he names *magnetocrystalline* force; whilst Plücker, on his part, widened its field by his beautiful and numerous researches on the manners in which crystals place themselves between the poles of an electromagnet; and Tyndall, the worthy successor of Faraday at the Royal Institution, by his ingenious experiments analyzed the phenomenon in its generality and succeeded in connecting it, in a perfectly satisfactory manner, with the laws which govern magnetism and diamagnetism. Subsequently Tyndall succeeded also in demonstrating, by a decisive experiment, that diamagnetism, like magnetism, is due to a polarity caused by the influence of the magnet in the diamagnetic body, but with this difference, that, instead of opposite poles, homonymous poles are developed by the poles of the magnet. Thus fell to the ground all the other more or less rash attempts at explanation which had been given of diamagnetism.

Another point which deserves attention is the investigation which Faraday made of the magnetism and diamagnetism of gases. He arrived at this curious result (observed likewise by Edmond Becquerel at the same time), that of all gases oxygen alone is magnetic, and this in a very marked degree, while all the other gases are diamagnetic. Considering the great part taken by oxygen in the composition of our atmosphere, he attempted to explain, by the magnetic properties of this gas combined with variations of temperature, the phenomenon of the diurnal variations of the magnetic needle which he traced over all parts of the surface of the globe. It is impossible for us not to regret a little the considerable time which he devoted to this investigation, especially as it appears to us very probable that it is not in the action of the atmosphere, but much rather in that of the earth itself, or perhaps even in that of the sun, that we must seek the cause of all the phenomena presented by the magnetic needle.

Lastly, a third point remains to be noticed, namely, that which relates to the investigation of the magnetic field and of what Faraday denominates the lines of magnetic force. According to him, as we have already had occasion to remark, there is no such thing as action at a distance; consequently the magnetic field (that is to say, the space included between two approximated magnetic poles, such as those of a horseshoe magnet) is a medium from which, in every one of its points, forces emanate, the distribution and direction of which are indicated by the very regular arrangement affected by fine iron-filings placed in this space. The lines which he calls lines of magnetic force thus become visible and even tangible. But they exist none the less even when we cannot see them, and it is the displacements or modifications which they experience by the presence of a ponderable body in the medium in which they occur that give rise to all the remarkable effects of which the magnetic field is the scene. Such is, in a few words, Faraday's view upon this particular question.

We pass in silence over a multitude of interesting details upon diamagnetic polarity, upon the distinction to be set up between magnetic and diamagnetic bodies, and upon the possible relation between gravity and electricity. In 1850 Faraday reverted to this question, which he had previously attempted but without success. We see that it is with regret that he is obliged to relinquish the discovery of this relation, which he had twice sought after; but with his usual good faith he admits that, although convinced that it exists, he was unable to find any fact to establish it. If experiment, which he knew so well how to employ constantly, gave him a negative response, would not this be because his point of view was not correct? and did not his error arise from his forming too vague ideas as to the transformation of forces, not taking sufficiently into account that it is the work effected by the force, and not the force itself, that must be considered in questions of this kind?

V.

We have passed in review the principal labors of Faraday; and it only remains for us, in order to complete this notice, to endeavor to form an idea of the special character of these labors, and of the influence which they have exerted on the progress of science.

The first character that strikes us is their number. What Faraday published in the form of memoirs from 1820 to 1855 icredible. And what would it have been if, side by side with nultitude of experiments which he has made known, we d in a parallel series those which he never published ? It e that if he has left them buried in his journal, it is be- they gave him negative results; but from how many ess essays and erroneous attempts he would have preserved ific men if he had not been so discreet !

second character is the exactitude of the results obtained: not think that Faraday has once been caught in a mistake; cise and conscientious was his mode of experimenting bserving. It must be admitted that in him the hand llously seconded the head; he was of remarkable dexter- nd possessed a practical talent, rare and precious in men ence, which enabled him, when necessary, to construct nodify his apparatus for himself, with the view of attain- ith more certainty the desired result.

hird character, of quite a different kind and of much r value, is the originality of the works of Faraday. A le of Davy, he undoubtedly shows traces of the school which he came, especially in the choice of the subjects ich he treats; but he does not blindly follow either the d or the steps of his master, and, soon quitting the n track, he strikes out a path for himself. What is this ? I shall be asked. This is not easy to say ; but I will theless attempt it.

the commencement of the present century, thanks to the tant works of which it had been the subject, the science ysics had acquired a character of precision and clearness seemed almost to make of it a mathematical science. ine treatise, in four volumes, on Experimental and Math- cal Physics, published in 1816 by M. Biot, gives the correct and complete idea of the point at which this sci- nad arrived. To the confusion which still reigned in the e of the eighteenth century between the various depart- of the science, to the ignorance which then still pre- l upon a great number of these departments, succeeded a and substantial analysis of all the phenomena, brought simple and rigorous laws. Heat, light, electricity, and etism were regarded in it as so many distinct agents, g their special properties and obeying their own laws. lation was admirably fitted to these clear and precise con- ns; hence we find it greatly used, as witness the very title Biot's treatise.

e great discovery of Œrsted (in 1820), upon the relations ng between electricity and magnetism, began to diminish lence in this mode of considering the phenomena, a confidence which was already a good deal shaken by the researches of Fresnel and Arago upon light. The breach once opened, the fortress was soon entered; and among the most intrepid assailants Faraday figures in the front rank. By his researches on the condensation of gases, he shows that there is nothing absolute in the laws of Mariotte and Gay-Lussac and in the distinction so generally accepted between vapors and permanent gases. By his investigations upon voltaic electricity, he establishes between chemical affinity and the production of electricity a relation so intimate that it seems as if the one was only a form of the other. By his discovery of induction, he brings in mechanical movement as an important element in the production of electrical phenomena. By his experiments on the influence of the magnet and of electricity on polarized light, and by those which were the consequence of it, he opens to science a new path which no one had foreseen. He succeeds thus in establishing between the natural agents which we name light, heat, electricity, magnetism, chemical affinity, and molecular attraction, such intimate relations, such a connection, that it is impossible not to think that we shall one day succeed in demonstrating that they are only different forms of the same agent. No doubt he is not the only one that has followed this path. Many others have brought in their contingent to this work of demolition and reconstruction; but he was one of the first, most active, and most persevering. Therefore his works, I have no doubt, will always be regarded as corner-stones in the new edifice which we are now endeavoring to construct.

I designedly say, *which we are endeavoring to construct;* for we must carefully avoid thinking that it is already constructed. Since the fine discovery of the mechanical equivalent of heat, it seems as if everything had been said and everything were easily explained by means simply of a ponderable matter, an imponderable æther, and a mechanical impulse. Vulgarizers of science, more anxious to produce an effect than to remain faithful to scientific truth, proclaim a molecular system of the world destined to form a pendant to the *Mécanique Céleste* of Laplace. According to them, nothing is more simple, nothing clearer; attraction itself, which has been the object of the study of so many superior minds, is merely the effect of an impulse easy to understand. A dangerous illusion! which, if it succeeded in propagating itself, would be as fatal to the true progress of science as opposed to its useful diffusion; for it is especially upon those who take to themselves the high mission of popularizing science that it is imperiously incumbent to spread none but correct and well founded ideas.

Let us not, however, exaggerate anything, or refuse to recognize in the too positive ideas which we have just combated that portion of truth which they may contain. With this purpose let us try, in conclusion, to lay down in few words the point at which, in our opinion, in the present state of science the important question of the unity of forces has arrived.

After having for a long time arrested the progress of science by abstract and general considerations upon the phenomena of nature, the philosophers finished by adopting, with Galileo, the experimental method, the only one that can lead with certainty to the discovery of the truth. A rigorous and profound analysis, placed at the service of this method, furnished certain and fundamental results. Reverting to a synthetic phase, many superior minds now seek by means of these tediously and painfully collected materials to reconstruct the edifice of which the raising was formerly attempted in vain. No doubt science has thus entered upon a fertile course, but only on condition of advancing with sure and consequently with slow steps. We speak of the unity of force, and of the transformation of forces one into the other; but do we know what are forces? do we know their nature? We have certainly proved transformations of movement, and shown that one work may change into another work, mechanical motion into heat, and heat into mechanical motion; these are, without doubt, the most important points gained by science, and enable us to get a glimpse of the existence of a single cause manifesting itself in various forms. But it is a long way from this to the discovery of this cause, this single force. Shall we some day arrive at it? It is possible and even probable; and in this case the name and works of Faraday will always remain associated with one of the greatest problems which the human mind can entertain.

Art. XIX.—*Contributions to Chemistry from the Laboratory of the Lawrence Scientific School.*—No. 5. *On a new process in Mineral Analysis;* by Frank Wigglesworth Clarke, S.B.

In the course of some experiments upon the alkaline fluorids, I found that the most refractory minerals, such as emery, chromite, tinstone, rutile, &c., were completely and easily resolved by fusion with a mixture of fluorid of sodium and bisulphate of potassa.

The operation is performed as follows. One part of the finely pulverized mineral is mixed in a platinum crucible with three parts of fluorid of sodium, and upon the top of this mixture are placed twelve parts of bisulphate of potash, which may be either in powder or in small lumps.

Upon heating, the mixture boils up strongly, and after a while settles into a clear, tranquil fusion. The boiling is chiefly owing to the action of the reagents upon the mineral, and not, as might be supposed, merely to the influence of the bisulphate upon the fluorid. This is shown by the fact that, whenever the reagents are heated together without minerals, although some boiling takes place, the addition of a little powdered chromite or iron ore fully doubles the violence of the action.

In quantitative analyses, it is necessary to keep the crucible closely covered in order to avoid loss from spattering; and to heat carefully, so that the mass may not boil over. The bisulphate should never be mixed with the fluorid and mineral, because a portion of the assay is then apt to escape action, being left on the sides of the crucible by the boiling of the mass; but should be placed upon the top of the mixture as above directed, as then the decomposition is complete. The mass obtained by this fusion, is, in the case of some minerals, completely soluble in water. In other cases, basic salts are formed, which, although insoluble in water, dissolve readily in hydrochloric acid. Almost all of the latter class may be rendered soluble in water, however, by the following process. The fused mass, after cooling, without removal from the crucible, is treated with a small quantity of strong sulphuric acid, and again fused. The mass thus obtained is entirely soluble in water. There are exceptions to this rule, however.

I will now describe the results I have obtained with various minerals, and for the sake of brevity, will speak of the fusion with bisulphate and fluorid as fusion No. 1, and the subsequent treatment with sulphuric acid, as fusion No. 2.

Tinstone is completely resolved, giving a white mass almost entirely soluble in *cold* water. A very small quantity of stannic acid remains undissolved, however, but by first treating the mass with hydrochloric acid and then adding water, complete solution is ensured. By rendering the solution *nearly* neutral, taking care, however, to leave a slight excess of sulphuric acid, then reducing the iron by sulphuretted hydrogen or hyposulphite of soda, and then boiling for sometime, all the tin is precipitated in the form of stannic acid. If the ore contains tungstic, niobic, or tantalic acids, these also will be completely precipitated. A second fusion is of no advantage with tinstone. This is the only mineral which I have yet tested, which was not completely resolved by this process, over an ordinary Bunsen's gas burner. This substance required the heat of a blast lamp.

Wolfram is entirely decomposed, affording a pale yellowish mass, partly soluble in water. Hydrochloric acid dissolves a part of the residue, but a white powder, probably the hydrate of tungstic acid, remains unattacked. Fusion No. 2 possesses no advantages with wolfram. I should not recommend the use of this process for the analysis of wolfram, as it is so readily decomposed by nitric acid. I made the experiment, however, because as wolfram is so often mixed with tinstone, it seemed to me necessary to know what the reaction would be.

Rutile.—This mineral is rapidly and easily resolved, giving a mass, when cooled, of a yellowish white color, and, as I obtained it, presenting a beautiful mottled appearance, being crystalline in structure, and in some parts nearly transparent, but opaque in others. This mass dissolved entirely in *cold* water, rendering a second fusion unnecessary. From this solution all the titanic acid may be thrown down by boiling.

Niobite is decomposed with the greatest ease. The mass is pale yellow, and partially soluble in cold water, but a small quantity of niobic acid remains undissolved, even in hydrochloric acid. But it is always best to treat with hydrochloric acid, in order to dissolve any basic sulphates of iron that may be formed. Upon boiling the filtered solution, niobic acid is precipitated.

Fusion No. 2.—A larger proportion of the mass is soluble in water than with the first fusion, as no basic salts of iron are present.

Ilmenite is completely decomposed, giving a mass closely resembling that obtained from rutile. *Cold water* dissolves a large part of this, but leaves some basic salts which dissolve readily in hydrochloric acid.

Fusion No. 2.—The resulting mass dissolves completely in *cold* water, and by boiling the solution, the titanic acid can be precipitated.

Chromic iron ore is decomposed very easily. In one case in which I timed the operation, *the fusion was complete in less than three minutes from the time I began to heat,* and that over an ordinary Bunsen's gas burner. The cooled mass is light green, partly soluble in water alone, and entirely soluble in hydrochloric acid.

Fusion No. 2.—The mass possesses a deeper green color than that obtained by the first fusion, and a larger proportion of it dissolves in water. In every fusion that I have yet made of chromite, however, a small quantity of basic salts was formed, requiring treatment with hydrochloric acid.

Emery is rapidly and easily resolved. The mass contains basic compounds that require hydrochloric acid for complete solution; although water dissolves a large proportion of it.

Fusion No. 2.—The mass thus obtained is entirely soluble in water.

Hematite.—(An exceedingly hard specular ore from the Tilden mine, Lake Superior). It was completely resolved, giving a mass partially soluble in water, but dissolving entirely in hydrochloric acid.

Fusion No. 2.—The mass dissolves completely in water.

Limonite and *magnetite* behave exactly like hematite.

Zircon is entirely decomposed. All its silica is converted into the gaseous fluorid of silicon, and driven off. The mass obtained resembled that given by rutile. It dissolved almost entirely in cold water, but the solution speedily became turbid and deposited a white precipitate, which was either Zirconia or some basic salt of that oxyd. By first digesting the mass with a little strong hydrochloric acid and afterward adding water, the whole went into solution.

Fusion No. 2, afforded a mass of a beautiful waxy luster, which was completely soluble in water.

Kyanite is entirely resolved, and, like zircon, freed from silica. The white mass contained basic compounds, and consequently required hydrochloric acid for complete solution. A second fusion gave a mass entirely soluble in water.

Orthite is completely decomposed, and deprived of silica. The mass was white, and dissolved partly in water. The insoluble residue contained basic salts and some sulphate of lime, and hydrochloric acid dissolved all but the latter.

Fusion No. 2.—With the exception of a little sulphate of lime, the mass dissolved in water.

Quartz sand.—I subjected some of this substance to fusion with the mixture of bisulphate of potash and fluorid of sodium, in order to ascertain to what extent silica would be converted into fluorid of silicon. The fusion took place very easily, giving a white mass which dissolved almost entirely in water. Only a very small trace of insoluble residue remained, probably not more than one tenth of one per cent of the quantity of sand taken. It is very probable that more careful treatment would get rid of even that small amount. After this it seems impossible to doubt that any and all silicates would be decomposed and freed from silica by this process. A convenient method is thus afforded for the estimation of bases in silicates, bearing in mind, however, that a second fusion with sulphuric acid will in most cases be necessary.

As far as concerns the complete resolution of any mineral, pure, finely pulverized cryolite may be substituted for fluorid of sodium. It labors under the disadvantages, however, of introducing alumina into the mass obtained, but nevertheless it can be advantageously employed in cases where the introduction of alumina is a matter of indifference, as in the technical analyses of tinstone and chromite, and the estimation of iron in ores, slags, and cinders. The perfectly white translucent specimens of cryolite should be chosen for this purpose.

Either the bisulphate of potash or of soda may be used, and although neither seems to possess any advantage in point of thoroughness, the potassa salt appears to be the most readily fusible, and is therefore to be preferred.

The following are the advantages that I claim for this process.

First. Speed. Among the different minerals upon which I have tested the action of this mixture, I have found no case where I was obliged to heat longer than five minutes, and many fusions are complete in three, and even less.

When bisulphate of potash *alone* is used for a similar purpose, it is usually necessary to heat for from half to three-quarters of an hour; and even then in the cases of emery, chromite, and some other minerals, it is almost impossible to obtain absolutely complete resolution.

By my process, even when the second fusion with sulphuric acid is necessary, not more than twenty minutes should be consumed in both fusions and the time for cooling between them.

Second. In every case except tinstone that has come under my observation, in my process, an ordinary Bunsen's burner may be used as the source of heat; whereas, by most other methods, a blast lamp is necessary.

Third. When bisulphate of potash *alone* is used for the decomposition of chromite, etc., it is necessary that the mineral should be reduced to extremely fine powder; but, when the mixture of bisulphate and fluorid is employed, although the mineral should be in fine powder, such an extreme state of subdivision is by no means required, and thus much labor is saved.

Fourth. In all cases when this mixture is used, the resolution of the mineral is absolutely perfect. Furthermore, all the silica is got rid of at once, and all the bases present are converted into sulphates. This last is a great advantage whenever iron is to be determined volumetrically by means of hypermanganate of potassa solution. As far as thoroughness of action is concerned, or generality of application, I can claim no advantage for my process over the use of acid fluorid of potassium; but the last named reagent is difficult to prepare, and when prepared, cannot be preserved in glass vessels.

Fluorid of sodium is subject to neither of these disadvantages, and in the mixture with bisulphate of potassa, has slight advantages as regards rapidity of action.

It may not be out of place for me to mention here a fact connected with the use of fluorid of ammonium for decomposing silicates, as described by Rose. After fusing the mineral with the fluorid, he directs treatment with sulphuric acid, for the purpose of converting the bases into sulphates. I find that if, in the first place, sulphate of ammonia is mixed in excess with the fluorid, all the bases are directly converted into sulphates, thereby obviating the necessity of treatment with sulphuric acid.

This method *can* be used for the purpose of determining alkalies in silicates, but is far inferior to J. Lawrence Smith's process.

Technical determination of chromium in chromite.—After fusion with cryolite and bisulphate of potash as previously directed, the mass is to be treated with a little strong hydrochloric acid, and allowed to digest for about ten minutes. Then, upon boiling with water, the whole dissolves. The solution should then be neutralized, acetate of soda added, and the chromium oxydized to chromic acid by a current of chlorine gas, or by boiling with hypochlorite of soda solution. The chromium may then be separated from other substances as directed in Prof. Gibbs's paper in this Journal for Jan., 1865. When chromite is fused with bisulphate of potash and cryolite, and saltpetre is added to the mass, as soon as clear fusion is obtained, the chromium is nearly all oxydized to chromic acid. If the mass be boiled with a solution of carbonate of soda and the liquid filtered, a filtrate is obtained which contains nearly all, but not quite all the chromium as alkaline chromates, free from iron or alumina; but, invariably, the residue upon the filter contains traces of chromium. When chromite is fused with the acid fluorid of potassium, a part of the chromium is usually oxydized to chromic acid by the oxygen of the air; and in one case that came under my observation, when I came to heat the resulting mass with sulphuric acid, red fumes were given off, which were probably the so-called terfluorid of chromium.

Technical estimation of iron in ores, slags, and cinders.—After fusion with cryolite and bisulphate of potash, the mode of treatment varies according to the method it is desired to use for determination of the iron. If Penny's process of estimating iron volumetrically with bichromate of potassa, or the ordinary method of precipitation with ammonia is to be employed, the mass may be treated with hydrochloric acid, and thus brought immediately into solution. If, on the contrary, e iron is to be determined volumetrically by means of hyper-anganate of potassa, the use of hydrochloric acid is inter-icted, and it becomes necessary to fuse again with sulphuric id and dissolve in water. When volumetric processes are ed, the whole determination of the iron, from the time the say is placed in the crucible, should take less than an hour to erform.

This process has a great advantage over all others, in the amination of ores, slags, and cinders containing iron, both s regards speed and convenience. A perfectly clear solution immediately obtained without filtering, all the silica is got d of, and it is only necessary to reduce the iron with hydrogen, nd then to titrate. If in an iron ore it is desired to determine lso titanic acid and manganese, it is best to make the subse-uent fusion with sulphuric acid. The clear solution obtained diluted to a known quantity, and by means of a graduated ipette divided into several portions. In one part the iron may e reduced and determined volumetrically; in another, the ti-anic acid thrown down by boiling. In still another portion, he iron, alumina, and titanic acid may be thrown down by oiling with acetate of soda, and in the filtrate, the manganese ay be precipitated by a current of chlorine gas, or by boiling ith hypochlorite of soda. If fluorid of sodium be used in-tead of cryolite in the fusion, lime and magnesia also may be stimated. For determining silica, phosphorus, and sulphur, ther methods must be employed.

Preparation of fluorid of sodium.—When pure finely pul-erized cryolite is boiled with caustic soda solution, it is, as is ell known, decomposed. Fluorid of sodium is deposited as a elly-like mass at the bottom of the vessel, and the supernatant iquid contains aluminate of soda, a little fluorid of sodium, nd the excess of soda. The deposit of fluorid is to be washed ith cold water until the washings have no longer an alkaline eaction; and is afterward purified by repeated solution and vaporation. It is so difficultly soluble and crystallizes so bad-ly, that this last is a matter of some difficulty; but the first part of the process is so very easy that the crude fluorid of sodium can be prepared by the hundred weight without much trouble. Iron vessels are suitable for the operation, but must be very clean and free from rust. If caustic potassa be substituted for soda, the deposit of fluorid of sodium is smaller, and the supernatant solution contains aluminate of potassa, fluorid of potassium, and a little fluorid of sodium.

Possibly the fluorid of potassium might be prepared in a state of purity from this solution, but it is extremely problematical whether this could be done economically. When pure cryolite is fused with carbonate of soda, and the fused mass powdered and treated with water, fluorid of sodium is dissolved out. This method, however, cannot compare with the first for convenience and economy.

It may not be altogether out of place to remark in this connection, that I find that when fluorid of sodium is heated with sulphate of ammonia, fluorid of ammonium is formed and sublimes. Possibly this may be turned to advantage, although I have made no experiments upon obtaining fluorid of ammonium in quantity by this process.

Before closing this paper I also wish to state that I made numerous experiments with a view toward applying the mixture of fluorid of sodium and bisulphate of potash to the estimation of both oxyds of iron when they occur in minerals; but I met with no success.

During the course of the experiments described in this paper, I have been largely indebted to Dr. Wolcott Gibbs for many very valuable suggestions and much excellent advice which aided me exceedingly.

Art. XX.—*Reëxamination of the localities of Human Antiquities at Abbeville, Amiens, and Villeneuve*; by E. Andrews, A.M., M.D., Professor of Surgery in Chicago Medical College.

During a recent sojourn in Europe, I relieved the arduousness of other duties by an occasional examination of famous geological localities. During these visits, some facts fell under my notice, which I have not seen mentioned in European works, and others forced upon my mind totally different inferences from those usually drawn. Among the localities visited were Amiens, Abbeville, and other points of the valley of the river Somme in France, in whose gravel beds are found flint hatchets and the bones of Man in connection with the bones of the *Elephas primigenius*, the *Rhinoceros tichorhinus*, and other extinct animals. The river Somme is a small stream, apparently about fifty feet wide, meandering along the flat floor of an ancient watercourse of much greater dimensions. The valley is about a mile and a half in breadth from summit to summit of the bluffs, and not far from two hundred feet in depth. In the lower part of its course, it is purely a valley of erosion excavated in soft chalk; but above Amiens it expands into wide irregular basins, which are apparently the natural undulations of the surface, which existed before the land rose from the sea, and which are now connected by valleys of erosion extending from one to another. Upon the floor of the valley and extending far up the slopes of the sides in many places are the famous gravel beds, which sometimes attain a thickness of 20 feet. Upon the lowland gravels rests a bed of peat about twenty-six feet thick. The discoveries in this valley have mostly been made by Mr. Boucher de Perthes, of Abbeville, who appears to have used great care to avoid mistakes, and to whose courtesy I am indebted for much valuable information. Boucher de Perthes finds in the gravels, as I have already said, the bones of the *Elephas primigenius*, the *Rhinoceros tichorhinus*, and other extinct animals in such connection with the bones of men, rude flint hatchets and other human relics, as to indicate that these great extinct pachyderms have been cotemporaneous with Man. They seem, however, to have become extinct at the time of the gravel deposit, for they are not found in the peat above. Boucher de Perthes inclines to the idea that the gravels were the product of diluvial epoch, whose disturbances exterminated these animals.

The European geologists frequently speak of the flint implements of the gravel as found in the "drift." American readers may need to be reminded that the gravel of the Somme is not genuine glacial drift, such as bears that name in America, but simply a river deposit of more recent date. It is restricted exclusively to the valley, and appears much like the gravel beds flanking the river valleys of the western states, which also contain the bones of elephants, and are invariably found above the true drift.

The question of the antiquity of these relics is one of great interest, for conceding their genuineness, of which there is little doubt, it is necessary to suppose that the *Elephas primigenius* has lived later, or Man earlier than is usually believed. The answer to the problem is sought by estimating first, the probable time consumed in the deposit of the gravel, and secondly, of the peat overlying it.

Sir John Lubbock believes that the gravel was an extremely slow product of deposition, occupying untold ages in its formation. He contends that it was gradually formed by the river, while it was slowly excavating the valley from the chalk, and that the stream at that time had but little greater annual quantity of water than it has now; but that its flow was less even, more of it being concentrated into the spring floods.

In the gravel pits near Amiens, I observed some facts which have an important bearing upon the question of time. There is evidence there that at the time the deposit was formed, blocks *of ice, or of mixed ice and frozen* gravel, three or four feet in diameter, were laid down in the strata, and that these blocks were completely covered and had other strata laid above them, before they had time to melt. There is also proof that the river, which did this work, had a volume not less than 1000 times that of the ordinary summer stream of the Somme. The facts are these: the mass of the upper gravels consists of chalk flints mixed with angular fragments, powder of crushed chalk and rolled chalk pebbles, the whole being of a light gray tint. Above this there is a stratum of gravelly clay of a blackish brown color, a few inches in thickness. Over this is gravel of a lighter brown, and above that, next to the soil, there is about 18 inches of a brown clay used for making brick. In the gray gravel there are places where the upper strata have sunk down as if into a cavity, filling it with material belonging higher up. The uppermost strata of all are undisturbed in position as though the sinking had occurred, and the surface been washed level again, before the latter were laid down. One of the best examples was on the south side of the upper gravel pit, above Amiens, where the perpendicular bank showed a fine section of the phenomena. At this place the strata of gray gravel were missing for a horizontal distance of about four feet, the space being filled with confused materials from the dark colored strata above. The sides of the interrupted space were nearly perpendicular, and I at first supposed that an ancient pit or well had been dug there, and filled again from above. A closer inspection, however, showed that the supposed pit had never been open to the external air. Tracing upward from the bottom until I came to the thin stratum of dark gravelly clay, I found the following singular appearances. The dark stratum had evidently once been continuous across the space, and had never been removed by any excavation. It had, however, from some cause settled until it broke in the center, the ruptured ends flexing downward until they hung almost perpendicularly on each side of the space, while the material from above had pressed down and filled the interval. It was evidently not an artificial excavation, as it would have been impossible to dig in such a way as to leave the clay stratum in that singular position, and equally impossible for water to deposit it originally in such a form. The conclusion is inevitable, that a mass of some material was imbedded there which occupied the space until the gravel covered it and the clay stratum was laid over it. This mass then in some way disappeared, allowing the clay stratum to settle and break, and the upper gravel to press in and occupy the vacancy. What was this temporary mass? All the circumstances indicate that it was a block of ice, or at least of frozen gravel and ice combined, with enough of the latter to leave a vacancy when it melted. An examination of the gray gravel adjacent confirms the idea of powerful ice action. It consists of chalk flints, mixed with broken chalk of every size, from a fine powder up to fragments as large as a man's head. Many of the fragments, though soft enough to write with upon a blackboard, have preserved with absolute perfection the sharp angles and edges which they had at the time they were broken from the cretaceous strata. It does not seem possible that they could have been rolled a hundred feet in the bed of a stream without losing this sharpness. It follows that much of the material of those beds was either dropped from floating ice, or else deposited by the mechanical action of ice fields floating down the ancient river, which crushed the edges of chalk strata abutting on the valley, and pushed the debris along to be left wherever the irregularities of the channel permitted. The agency of ice is further evinced by the occasional presence of large boulders of sandstone in the gravel, some of which weigh a ton. These must have been transported from far up the stream, as the rocks in the vicinity are exclusively chalk. The crushing action of ice against the edges of the valley is rendered more probable by the fact that the angular mixed gravel is found only in the border beds, while the strata nearer the center of the valley are washed comparatively clean of chalk.

The envelopment of ice and frozen gravel in sedimentary beds is by no means a phenomenon peculiar to the valley of the Somme. In a former article, I described the angular masses of loose clean gravel which occur in the drift clay beneath the bed of Lake Michigan. These masses occur in such shapes and positions as to show that they were deposited in a frozen state, and that they must have been completely covered with clay before they had time to melt, otherwise the loose gravel of which they are composed could never have maintained their peculiar forms and positions. These masses have furnished an extremely valuable means of estimating the rapidity of deposition of the drift clay of that locality.

If the phenomena in the valley of the Somme were produced in the way I have supposed, it follows that portions at least of the gravels there were deposited with extreme rapidity, insomuch as blocks of frozen material four feet in diameter were completely covered and had horizontal strata laid above them before they had time to melt.

The evidence of powerful force exhibited in the gravel beds of Abbeville and Amiens renders untenable Sir John Lubbock's theory that the valley was excavated by the imperceptible action of the river at about its present annual amount of water.

The valley of the Somme is over a mile and a half at the top, while the present river does not appear to exceed fifty feet in breadth. It is safe to say that the present stream spread over the whole valley, would not be half an inch deep, and making all probable allowance for spring floods, it is wholly inadequate to the production of gravel beds containing pebbles larger than a man's head, and boulders weighing a ton. This valley presents none of the characteristics of those which are widened by the irregular meandering of a shifting narrow stream, now eroding this bank and now that. It is broad, level-floored, and parallel-banked. The stream that excavated it filled it from bluff to bluff. Now the marginal gravel banks are often fifteen or twenty feet thick, and have horizontal strata. It follows that when the upper strata were laid down, the stream during its floods was a mile and a half wide and not less than twenty feet deep. It is proper to add, that farther up the stream the valley presents different characteristics and does not appear to have been formed altogether by erosion. Above Amiens it often widens out into vast irregular basins without definite boundaries. These appear to be the natural undulations of the surface already alluded to, and are connected to each other by valleys of erosion. If the land rose gradually from the ocean these wide inland basins would temporarily have the character of lagoons, and the flux and reflux of the tides would cut channels of communication in the soft chalk extending from the upper to the lower, thus sketching out the lines of the subsequent river beds. It is probable, therefore, that the outline of this river system was formed at the time of the elevation of the chalk from the sea, and that the valleys have been simply modified and not created by fresh-water erosion.

The conclusions to be drawn would seem to be these:

1. The ancient river, and consequently the ancient annual rainfall, was for a time immensely greater than at present.
2. The rapidity of the gravel deposit was, at least in places, very great, and the time required for it proportionately short.

Overlying the gravel of the floor of the valley is a bed of peat about twenty-six feet in thickness. Mr. Boucher de Perthes has with praiseworthy care sought for means to determine the age of this bed; but, as he was probably unacquainted with the phenomena of forest peats in process of actual formation, he has very excusably overlooked some of the most important data. Such an error is not to be blamed in Europe; because, where few trees are allowed to grow, and none to decay, the study of such phenomena is impossible. As the result of his observations, he concludes that the average increase of the peat has not exceeded four or five centimeters (1½ or 2 inches) in a century. He states that there has been no perceptible accretion to it from time immemorial, so far as the observation of the modern inhabitants can determine. He believes that had the growth been more rapid than his estimate, the fact could not have escaped notice. Now the thickness of the peat being about 26 feet, an increase of 1½ to 2 inches a century would imply an age of from 15,600 to 20,800 years for the whole bed, or for the entire period since the termination of the gravel deposits. These figures must, however, be greatly modified before they can be accepted by one acquainted with actual forest life. Boucher de Perthes elsewhere states that he has found deep in the peats of the Somme numerous trunks of trees standing erect where they grew, generally birches, or alders. These trunks were sometimes a meter (39·14 inches) in height, but generally less. Now as stumps of trees do not stand long uncovered in the damp air of a swamp without decay, it follows that all which are found standing erect in the peat, must have been covered to their present summits with the increase, before they had time to rot away. Applying Boucher de Perthes's estimate of 1½ to 2 inches growth of peat in a century, it would follow that a stump one meter in height must have stood uncovered without decay from 1,950 to 2,600 years before the accretion of peat overtopped it and secured its preservation. The absurdity of the idea is obvious at a glance. One hundred years is a long duration to allow even an oak in such circumstances, and every trace of almost any other deciduous tree of the latitude would disappear in less than fifty years. Birch stumps are especially perishable. If, however, we allow a duration of a century to the tallest stumps, it is obvious that there are places in the valley of the Somme where the peat has increased three feet or more in a hundred years. This conclusion is confirmed by the existence of numerous prostrate trunks. Some oak logs have been found in the peat four feet in diameter, and so sound that they were manufactured into furniture: unless these trunks fell into a pond of water and were thus preserved, they must have been covered by the accretion of the peat before they had time to decay, say within a hundred years after they fell. The supposition that these trunks may have buried themselves by the force of their fall is not admissible, because no oak will bury itself by its fall in a soil solid enough for it to grow upon when alive.

The remark of Boucher de Perthes, that the growth of the peat is so slow as to be wholly imperceptible to the modern inhabitants, is doubtless true and very easily explained. The beds of the Somme belong to the class of forest peats, and not to that of the moss growths. Forest peats, as may be seen in thousands of localities in the United States, are formed as follows: The annual crop of fruits, twigs, leaves, and windfall trunks, furnished by the trees and shrubbery of a dense swamp, amounts to an immense mass of vegetable matter. These added to a thick undergrowth of grass, herbs, and moss, are all pressed against the ground by the winter snows. In the spring they are flooded and protected from decay. In the summer they are partly protected from oxygenation by the extreme wetness of the soil into which they have been pressed. Hence they are only slightly rotted when they are finally covered up by the fall of the next autumn's crop. To one who studies the actual quantity of this material, a growth of two or three feet in a hundred years is by no means incredible. Thus the increase of the peat depends upon the presence of the forest; but the valley of the Somme has lost its forests centuries ago. It is wholly reduced to cultivation and pasturage. Hardly an ounce of grass or a stick of wood ever rots upon it, but every particle of vegetable matter is removed for the use of the inhabitants. About Amiens, the ground is all drained, and used for market gardens, and in other parts it is all sown with crops, mown for hay, or grazed for pasture. The peat growth, therefore, is arrested for want of material, and no further increase will be observed though a million years should elapse. Hence all calculations of age, based on the present want of progress, are necessarily erroneous.

In the excavations of the peat, Boucher de Perthes distinguishes near the surface relics of the middle ages: below that to the depth of about six feet Roman and Gallo-Roman remains, and underneath that, pure Gallic and other earlier traces. I have no means of knowing how long ago the forests of the Somme disappeared, but I presume those parts occupied by Roman garrisons would be among the larger settlements, and be earliest cleared of timber. Probably the places where Roman remains are found may have been destitute of timber, and produced little or no peat for the past six or seven hundred years. If so, the deposit of six feet of peat over the earliest Roman remains was accomplished in about 1200 years, or at the rate of about six inches in a century. This is much less than the rate required to preserve a stump three feet in height, but the latter was plainly a maximum. Most of the trunks were shorter, and in many places they seem to have disappeared altogether. While it is evident that the accretion in some times and places has been as high as three feet in a century, the average rate must have been lower, and very probably did not exceed six inches per century indicated by the depth of the Roman remains. *If this be taken as a probable standard, the age of the whole bed, whose thickness is about 26 feet, would be not far from*

5200 years down to the cessation of peat growth, or, adding the six or seven hundred years supposed to have elapsed since the clearing of the ground, the present age of the bed would be about 5800 years. It is impossible to pretend to minute accuracy in such calculations, but the above results are at least based on tangible data, and serve to show that in the eyes of practical woodsmen, the enormous European estimates of time greatly need pruning.

During my sojourn on the Continent, I twice examined the gravel cones of the Tinière, near Villeneuve, on Lake Geneva, which have been made familiar to geologists by the investigation of Morlot. Unfortunately I have not at hand his original account, and am obliged to take his statements second hand, as quoted by Sir John Lubbock and others.

At the eastern extremity of Lake Geneva, situated upon the level bottom of the valley of the Rhone, is the little city of Villeneuve. From the mountains which rise abruptly over the very edge of the city, descends the torrent of the Tinière, which is dry part of the year, but at other times becomes a stream some fifteen feet in breadth. This stream brings down annually a certain quantity of torrent gravel which has been deposited in the form of a cone, or rather of a half cone upon the level plateau on the border of the lake. The apex of the cone rests against the side of the mountain, and the base extends in a semicircle around the mouth of the gorge from which the torrent descends. A railroad has been cut through the cone, thus exposing a section of the mass nearly to its base. The cone was found to be stratified in a very regular manner, not horizontally, but in curves exactly parallel to its surface. About four feet below the top was a stratum of black soil which contained Roman relics. At the depth of ten feet, implements of bronze were discovered in a similar stratum, and at the depth of nineteen feet another black layer contained only articles belonging to the age of stone. Morlot very properly judged this a favorable opportunity to estimate the age of the whole cone, and by inference the duration of the present geological epoch, and of the human race. His calculation is as follows: The entire depth of the cone at the center of the section is thirty-two feet and six inches, while the Roman remains are only found to the depth of four feet. Some two or three hundred years ago the increase of the cone was stopped by confining the course of the torrent between stone walls, which prevented any further spreading of gravel over the surface, and caused it to be swept onward into the lake. Allowing 300 years as the probable time since the walls were built, there still remain about 1300 to 1500 *years from the beginning* of the Roman domination to the cessation of the deposit, during which the cone was increased by the annual spread of gravel over its surface. It appears, therefore, that about four feet of gravel (1·14 meters) accreted in from 1,300 to 1,500 years, or not far from three and three-tenths to four inches in a century. Taking this ratio as a datum, Morlot, if I understand him correctly, applies it to the whole 32 feet 6 inches of depth, and decides accordingly, that the cone has an age of from 7,400 to 11,000 years. There are, however, two cones at Villeneuve. The one thus measured is the newer and smaller, and rests against the edge of a much larger one, which was formed before it, when the waters of the lake stood some fifty feet higher than at present. Now the upper cone is about twelve times as large as the lower, and, as Morlot infers, required twelve times as long for its accumulation, or from 88,000 to 132,000 years. The combined age of both cones, therefore, would by this calculation be between 96,000 and 143,000 years. It is with great hesitation that I question the conclusions of an European savant, made respecting his own country; but having twice examined these cones with great care, and followed the torrent a mile into the mountains to study its appearance and action, I cannot avoid the conclusion that there is a very singular mathematical error in estimating the age of the cones, and an omission of several important geological facts which vitiate the whole calculation. The nature of the mathematical error will be made obvious by a few facts. The gravel cones of Switzerland are very numerous, and the principle of their formation easily understood. On the supposition that the torrent brings down about the same amount of gravel each year, it will readily be seen that the first year's deposit will lie upon the plateau in a conical heap of no great breadth, but of considerable height. The second year's gravel however, will be spread over the entire surface of the first, and extending wider, it must be much thinner. The third year's accretion will be broader and thinner still, and so on to the last. It follows that the superficial annual layers are always the thinnest, because the broadest. Now, if Morlot is correctly quoted, he first derives his scale of from three and three-tenths to four inches increase per century from the superficial layers where they are thinnest, and then applies it without modification to the interior where the annual accretions were much thicker. His unit of measure is therefore too small, and exaggerates the total age. It is perfectly plain that the true method is to take the cubic contents of the strata whose age is known, and compare the amount with the cubic contents of the whole cone; or, in plain language, if the annual rainfall and gravel wash has been uniform, then as the quantity of gravel in the layers deposited since the Roman conquest, is to the quantity in the whole cone, so is the time required for the deposit of these layers, to the time required for the formation of the whole cone.

The revised data and calculation would be as follows. The lower cone is really a half cone, the apex resting against the declivity of the upper one, and the base being a semicircle. The dimensions are nearly as follows:

Height of apex, 38 feet.

Radius of the base, 900 feet.

Cubic feet in the strata deposited since the Roman conquest, 5,283,205.

Time of deposition of the same, 1,300 to 1,500 years.

Cubic feet in the whole lower cone, 16,116,408.

Time of deposit of the same, 3,965 to 4,576 years.

Adding the 300 years, which have elapsed since the deposit ceased, the present age of the lower cone would be from 4,265 to 4,876 years.

It will be noticed that this is not far from the age which we estimated for the peat beds of the Somme. It would seem, therefore, that the period of higher water, which preceded both, was simultaneous at the two places.

The calculations respecting the upper and larger cone are vitiated not only by the overestimate of the age of the lower, on which that of the upper depends, but still more by leaving out of view several important geological facts.

The amount of gravel transported by a torrent, depends on the amount of water in it. Or, in other words, upon the annual rainfall. It is important to inquire, therefore, into this point. The fact that at the same period the river Somme had an immensely greater volume of water than now, and the water of Lake Geneva stood fifty feet above its present level, gives a probability that the torrent of the Tinière would be found affected by the same causes as the lake and the river. The examination of the upper cone itself settles this question, for it carries its history in the channels on its surface. The gravel cones of the Alps are marked with channels of a size proportioned to the quantity of water which flows in them, because the stones and gravel are left on each side of the water course up to high water mark, showing the exact size of the stream. As the gravel accumulates it gradually raises the bed of the torrent above the rest of the cone, until the water breaks through now on this side and now on that, and distributes its gravel over the lower portions. Hence the comparison of the torrent channels of the two cones, will show the size of the stream which formed them at the two periods. Now the bed of the

Tinière in the lower cone is only about 10 feet deep and 20 feet wide, while in the upper cone the old torrent bed is over 15 feet deep and 300 feet wide, making quite a valley, which in modern times is never one-twentieth part full of water, and is covered with vineyards. Other parts of the surface show traces of the torrent's magnitude when on its lateral wanderings. All the marks of water action in the upper cone are on a gigantic scale, compared with those of the lower. The same conclusion is supported by the appearance of the gorge from which the stream issues. For nearly a mile into the mountains, one may see distinct terraces of such size and position as to show that the stream has at some period been immensely larger than at present. It follows, therefore, that the rate of deposition during the formation of the upper cone was very much greater than in the lower, and the time occupied proportionately short, but we have no means of applying an exact measure for its determination.

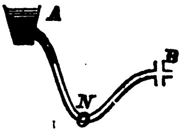
It is possible, however, that this violent action may not have existed during the whole formation of the cone, and if so, the center may be older than the surface indicates. I believe the Alps at this point are considered to have been elevated in the earlier half of the Tertiary period, and I observed fragmentary terraces of glacial drift within the jaws of the gorge in such a position as to show that at that epoch the valley was already in existence, and that it had nearly its present size. It must be true that as soon as the mountains were elevated, the torrent commenced to flow, and to form a cone. Now if the tertiary cone was not removed by the changes of the drift period, it must still exist beneath the surface, and constitute part of the whole mass. In that case the age of the cones is not a measure of the duration of the present epoch, nor of man's antiquity, but of the present and of all the past periods as far back as the Miocene or Eocene. However this may be, the following conclusions seem highly probable:

1. The tranquil period of the lower cone was synchronous with the period of peat formation in the valley of the Somme, and their age would appear to be somewhere from 4,000 to 6,000 years.
2. The violent water action of the upper cone was cotemporaneous with the corresponding activity of the Somme in the gravel period.
3. During this period, the water-flow was enormous, the gravel accretion extremely rapid, and the time occupied by the deposits correspondingly short.

ART. XXI.—*To ascertain the loss sustained in the delivery of water from a conduit pipe, when it is tapped by a branch at any portion of its length;* by THOS. GUERIN, Civil Engineer.

IN water works for the supply of a city it happens sometimes that it is necessary to convey the water in a conduit pipe from a reservoir situated at a long distance; and before the conduit reaches the point of distribution it is tapped by a branch so as to carry off a portion of the water for other special purposes, thereby interfering seriously with the proper supply for the city.

On examining the action of the branch it is easy to perceive that it causes an increase in the flow from the reservoir; while at the same time, it causes a diminution in the delivery at the point of distribution in the city, and moreover, the quantity carried off by the branch must be composed of such increase and diminution.



Thus, let A be a vertical section of a reservoir supplied from a river, or some other great source, and let ANB be a conduit pipe leading water to the point of distribution at B. It is manifest that if the pipe were cut at the point N, the delivery there would be greater than it had been at B before the pipe was cut, for the reason that a discharge through a pipe varies very nearly as the square root of the length inversely; it follows then that the discharge from the reservoir would be increased by cutting the pipe at the point N.

Again, if instead of cutting the pipe at N, an orifice were made in its side, such that the area of the orifice would be equal to the sectional area of the pipe, it is evident that almost as much water would flow through this orifice, as if the pipe were actually cut across at N (the only difference being the amount arising from a change in the direction of the fluid); while none can arrive at the point B, which is supposed to be a considerable distance removed from N. According as the orifice at N diminishes, so will the discharge from A diminish, and so will the water ascend toward B, until it commences to flow through at that point; and while the orifice continues to diminish, the flow will increase until it becomes a maximum, when N is closed; at that time the discharge from A is a minimum.

Again, if the orifice at N be made small at first, the delivery at B will be a little diminished, and while the orifice at N increases, this delivery will continue to decrease until finally it becomes nothing; while the discharge from A will increase until it becomes a maximum as soon as the orifice at N is equal to the section of the pipe.

It follows then, that when a branch is inserted in a conduit, the effect will be to increase the discharge from the reservoir, but at the same time to diminish the quantity delivered at the point of distribution; and the sum of such increase and diminution will be the exact quantity carried off by the branch.

To be able to ascertain this increase and diminution separately, as well also as the exact quantity delivered at the point B, is manifestly of the greatest importance in laying a system of water pipes; and although writers on hydraulics have investigated formulæ for ascertaining the quantity passing in a branch, yet as far as I can ascertain, its component parts and also the exact amount delivered at the point of distribution do not appear to have been hitherto discussed. Toward a solution of this question, I submit the following investigation.

On reference to *D'Aubuisson's Hydraulics*, translated by Bennett, we find in chapter 3, No. 186,

$$H-{\cdot}0251817\frac{Q^2}{D^4}={\cdot}0006769\frac{L}{D^5}(Q^2+{\cdot}141724QD^2).$$

This is a general formula employed for the solution of questions relating to the motion of water in conduit pipes; Q denotes the quantity flowing per second through the pipe; L, its length; D, its diameter, and H, the head on the orifice of efflux; the denominations of all these dimensions being feet.

The second member of the equation is the value of the resistance from friction occasioned by the sides of the pipe.

From this equation we obtain general values for H and Q as follows:

$$H={\cdot}0251817\frac{Q^2}{D^4}+{\cdot}0006769\frac{L}{D^5}(Q^2+{\cdot}141724QD^2)$$

$$Q=-\frac{{\cdot}070862LD^2}{L+37{\cdot}20D}+\sqrt{\frac{1477{\cdot}30HD^5}{L+37{\cdot}20D}+\left(\frac{{\cdot}070862LD^2}{L+37{\cdot}20D}\right)^2}.$$

Let us assume Q=the quantity delivered at B,
q=quantity carried off by branch,
L=length, NB,
l=length, AN,
H=height of reservoir above B,
D=diameter of pipe,
L=entire length of pipe, ANB.

On reference to the general value of H, it will appear that *the head* which forces the amount q to the point N, will be

$$\cdot 0251817\frac{q^2}{D^4}+\cdot 0006769\frac{l}{D^5}(q^2+\cdot 141724\,qD^2).$$

If H be diminished by this quantity and also by the friction due to the passing of Q through the length l, the remainder must be equal to the head which forces the quantity Q through the length, NB, viz:

$$H-\cdot 0251817\frac{q^2}{D^4}-\cdot 0006769\frac{l}{D^5}(q^2+141724qD^2)$$
$$-\cdot 0006769\frac{l}{D^5}(Q^2+\cdot 141724QD^2).$$

Let this quantity be substituted for H in the general value for Q as given above, and there will result

$$Q=-\frac{\cdot 070862LD^2}{L+37\cdot 20D}+\sqrt{\frac{1477\cdot 30D^5}{L+37\cdot 20D}\left(H-\cdot 0251817\frac{q^2}{D^4}-\cdot 0006769\frac{l}{D^5}(q^2+\cdot 141724qD^2)\right.}$$
$$\overline{\left.-\cdot 0006769\frac{l}{D^5}(Q^2+\cdot 141724QD^2)\right)+\left(\frac{\cdot 070862D^2L}{L+37\cdot 20D}\right)^2}.$$

Resolving this quadratic equation, the value of Q is found to be as follows:

$$Q=\frac{\cdot 070862D^2L}{L+37\cdot 20D}+\sqrt{\frac{1477\cdot 30}{L+37\cdot 20D}(HD^5-\cdot 0251817q^2D)-\frac{l}{L+37\cdot 20D}(q^2+\cdot 141724qD^2)}$$
$$\overline{+\left(\frac{\cdot 070862D^2L}{L+37\cdot 20D}\right)^2}.$$

Such is the value for Q in general; but when the velocity exceeds two feet per second, and that of L is great compared to 37 times D, in that case it will be seen by D'Aubuisson, No. 189, that $Q=37\cdot 548\sqrt{\frac{HD^5}{L}}$, and hence $H=\cdot 0007089\frac{LQ^2}{D^5}$. From this general value for H, it appears that $\cdot 0007089\frac{lq^2}{D^5}$ is the head required to force the quantity q to the point N; and as it appears from D'Aubuisson, No. 187, that $\cdot 0007089\frac{lQ^2}{D^5}$ is the friction due to the passing of Q through the length l; it follows that $H-\cdot 0007089\frac{lq^2}{D^5}-\cdot 0007089\frac{lQ^2}{D^5}$ denotes the head which would be competent to force Q through the length NB. Let this quantity be substituted for H in the value for Q, and there will result $Q=37\cdot 548\sqrt{\frac{HD^5-\cdot 0007089\,lq^2}{L}}$. This is a convenient formula for practice and it gives a correct result when the velocity exceeds two feet per second, and when the length is great compared to 37·20 D; two circumstances which almost invariably occur.

The formula for Q gives the delivery at the point of distribution before the branch is inserted; we shall therefore have Q−Q= the loss sustained by the insertion of the branch; and q+Q−Q= the increase of discharge from the reservoir arising from the same cause.

Department of Public Works, Ottawa, Nov. 14th, 1867.

Art. XXII.—*Notes upon some of the Mineralogical Curiosities of the Paris Exposition of* 1867; by William P. Blake.

The display of minerals in the department of Mining and Metallurgy, Class 40, of the exhibition was very extensive, and although composed chiefly of ores and metallurgical specimens, there were many objects of particular interest mineralogically, either for their rarity, their great size or beauty, or as coming from new localities. There was also a large display of precious stones, cut and polished, and of ornamental stones, both wrought and unwrought, such as columns, slabs, and vases of polished granite, porphyry, marble, and serpentine, or smaller objects of art in jasper, onyx, malachite, and lapis lazuli.

In these last mentioned objects the Russian collection was particularly rich. One of the most conspicuous was an elliptical vase about six feet high, sculptured at the Imperial establishment of Ekaterinburg out of a compact gray jasper from Kalkhansk. The shaft supporting the basin was ornamented by an entwined vine-branch with leaves and fruit exquisitely chiseled in high relief and polished. Two magnificent candelabra with pedestals of rhodonite were shown from the same establishment. These pedestals were about ten feet high, and nearly two feet broad at the base, but were probably formed of several pieces united. The rhodonite appears to occur in large homogeneous masses, and to be extensively employed for ornamental purposes. It takes a high polish, and has a pleasing rose-red color, slightly mottled with black.

Ivan Stebakoff, of Ekaterinburg, exhibited a great variety of beautiful paper-weights, made of polished slabs of jasper, malachite, and lapis lazuli, surmounted by groups of flowers or fruits in their natural colors, cut out of various highly colored ornamental and precious stones. The government establishment at Tiflis, Caucasus, sent numerous ornamental objects, some fashioned out of a kind of marble-onyx similar to the beautiful stalagmitic marbles of Algeria and Mexico, and others out of a peculiar chatoyant obsidian.

The wealth of the Russian empire in precious stones was well illustrated by a magnificent series of cut gems of the country from the Imperial cabinet. This contained amethysts, sapphires, emeralds, aquamarines, beryls, phenacites, white topazes, tourmalines, sphenes, and chrysoberyls, all of them of unusual size and brilliancy. Some of the phenacites which had a fine brown color when first shown, became bleached and colorless after exposure to the light.

The splendid displays of jewelry by the leading British and Continental jewellers contained a great variety of precious stones remarkable for their beauty and value. Hancock & Co., of London, exhibited a sapphire of fine color, one and a half nches long and three-quarters of an inch broad. One weighing 100 carats was shown by Mr. Mellerio.

Diamond.—In addition to the great numbers of large and well matched diamonds mounted in various ways for personal adornment, some of the exhibitors showed the gem in its various colors. Thus the following different colors were shown in a suite of nine beautiful diamonds in the case of Hancock & Co.: dark green, chrysolite-green, topaz-yellow, hyacinth-red, pink, cinnamon-brown, bluish-black with the luster of steel, and black with a lavender shade. A peculiar steel-like and graphite-like luster of the gem was well shown in a tiara and necklace formed of about forty stones, ranging from one-quarter of an inch to five-eighths of an inch in diameter, but not, however, wholly free from flaws.

In connection with the very interesting exhibition by Mr. Coster of Amsterdam, of the art of cutting and polishing diamonds, there was a remarkably fine display of the rough stones from all the principal diamond-producing localities. All the varieties of crystalline form and of color were shown, together with the minerals and rolled pebbles usually found associated with the diamonds in the deposits. In a suite of highly colored diamonds in this collection, there were two remarkable stones. One of 29 carats weight (about 92 grains), a pear-shaped brilliant, about three-quarters of an inch long, has the property of acquiring a rose-pink color, on being strongly heated. This color is retained in the dark after cooling, but if the gem is exposed to the light, the color soon vanishes. The experiment has been repeatedly performed with like results. Another stone with a beautiful bluish-black color by reflected light, appeared perfectly opaque when held between the eye and the light, owing, probably, to the total reflection of the light from the facets of the stone.

The collection contained masses of the crude black variety, known as "carbon," valuable for its powder. Irregularly shaped fragments of this are found with the diamonds of Bahia and are sometimes two inches in diameter. Another variety called "boart," is translucent, and appears to be a confused crystallization; it accompanies the diamonds of Rio, and is also only valuable for its powder.

The *cascalho*, a conglomerate, containing diamonds, evidently corresponds in its origin to the "cement" of gold miners, and consists merely of the various water-worn and heavy pebbles accompanying the diamonds in the beds of streams, cemented together on the bed-rock by ferruginous, calcareous, or siliceous infiltrations.

The yearly importation of diamonds from 1862 to 1866 has averaged 176,000 carats, nearly 1,000 lbs. troy. Over 400 persons are constantly employed in cutting diamonds at Mr. Coster's establishment.

Opal.—Some remarkably large and fine opals were shown by Emil Goldschmidt, of Lower Austria. The largest one, oval in form, and about two and a half inches long and an inch wide, was valued at 75,000 francs. Another stone with a triangular outline, about one and a half inches on a side, was valued at 50,000 francs, and an ellipsoidal specimen, one and a half inches long and three-quarters of an inch in diameter, at 30,000 francs. Some large masses of the rock inclosing opals were also shown. It is evident from these specimens that the opal is sometimes formed in horizontal layers at the bottom of cavities, nearly as agates and the onyx are formed.

Turquois.—A fine series of turquois specimens, in the rough and cut, was shown by Petiteau, of Paris. Several of the cut stones were as large as pigeons' eggs and of good color.

Beryl.—One of the ornaments of a massive piece of goldwork consisted of a bust of the Emperor, about one-third life size, cut out of a single aquamarine of good color.

Rock Crystal.—Many very large and transparent crystals of quartz were sent from Japan, where this mineral occurs in abundance, and is wrought into many ornamental objects. An optical examination of some of these crystals by DesCloizeaux showed that, like quartz of most other localities, they were very irregularly compound in their interior structure, none giving a uniform tint in polarized light.

Platinum.—A variety of pepites, or nuggets, of platinum were shown in the Russian section from the mines of Prince Demidoff, in Tagilsk, government of Perm, Siberia. The largest mass weighed 13 pounds. Many of the smaller masses were highly magnetic, attracting iron filings like magnetite, and possessing strong polarity.

Native copper with native silver.—A mass of native copper weighing 1400 lbs., and resembling the copper of Lake Superior, was sent from the Kirghise Steppes, Siberia. A small fragment of native silver, joined perfectly to the copper, as in the Lake Superior specimens, was observed in this specimen by Mr. Des-Cloizeaux.

Native silver.—The collection from the Kongsberg mines of Norway contained some extraordinary crystallizations of silver. Among these may be noted a cubic crystal three-quarters of an inch in diameter, with truncated angles; and a group of modified cubes, twenty or thirty in number, forming a mass about three inches in diameter. There were also some fine crystals of sulphuret of silver, and crystals of calcite penetrated with wire silver.

Proustite. — Some large groups of choice crystals of this species were in the collection from the mines of Chañarcillo, Chili, but the most extraordinary exhibition of this mineral species, in a massive form, was in the United States section, from the Poorman lode, Idaho Territory. The greater part of one of the masses weighing about 200 lbs. was composed of this mineral.

Torcornalite.—Among the silver ores sent from Chili, Mr. Domeyko notes a new species to which he has given this name; a double iodid of silver and of mercury, from the Alfinhallada mine, Tres Puntas.

Cryolite.—A mass of this mineral, three feet long and two feet thick, from Iviktout, Greenland, was exhibited by the Greenland Cryolite Mining Company. Nearly 20,000 tons of this mineral were shipped in 1866.

Allanite.—In large crystals from Avegeit, Greenland.

Iceland spar.—From Helgostad, Iceland. The end of a large crystal 2½ feet long and two feet in diameter at the base. One of the faces was studded with small implanted crystals of stilbite. The mass appears to be quite sound and clear, and, with other fine cleavage masses, to be suitable for optical purposes.

Malachite.—The Peak Downes Copper Co., of Queensland, exhibited a mass of malachite five feet three inches long and ten inches thick. A specimen from the Medno-Roudiansk mine, Siberia, the property of Paul Demidoff, weighed 2150 kilograms, about 4686 pounds, and was valued at 75,000 francs. Large masses of malachite were first found in 1840, since which upward of 1,260,000 lbs. have been taken out.

Graphite.—Mr. Alibert made a very interesting exhibition of graphite from Mount Batougol, near Irkoutsk, Siberia. It is remarkable for its uniform density, freedom from grit, for its blackness, and for a peculiar fibrous structure which shows upon the surface of the blocks like the grain of split wood. This structure has already been noted by General Kokscharov in his Mineralogy of Russia. Most of the masses exhibited are in the form of prismatic columns from one to three feet long, and a few inches only in thickness, looking as if they had been split out. It may be sawn and cut into any desired shape and gives sharp and firm angles and points, and is apparently well adapted for pencils, for which it is largely used.

Nephrite.—The exhibitor of the Siberian graphite sent, also, a large polished block of nephrite of dark green color weighing 1,000 lbs.

Stassfurth Mine Products. —This remarkable deposit of potash salts is being explored with increasing success, and its nature and products were well shown by specimens of the different minerals in connection with a very carefully made model. A large arched recess was built out of large blocks of the rock salt, in which the numerous wavy sheets of anhydrite could be easily seen. Glass jars arranged about this recess contained samples of carnallite, boracite, tachhydrite, kieserite, polyhalite and kainite.

Borax.—A very interesting series of specimens from the Borax lake in California was shown in the collections from that state. Some of the crystals were nearly six inches long, and from two to three inches thick. Smaller crystals occur of all sizes, and they are all found in a thick blue clay at the bottom of the lake.

Sulphur.—Mr. J. Mottura of Turin, exhibited a fine collection of crystallized sulphur, celestine, strontianite, and gypsum from Sicily.

Art. XXIII.—*Notes on the Lignite Deposits of the West;*[*] by F. V. Hayden, U. S. Geologist. Published by permission of the Commissioner of the U. S. General Land Office.

The construction of the Pacific Rail Roads across the continent is bringing about the dawn of a new era in the progress of the west. Already has the U. P. R. R., from Omaha, struck the first range of the Rocky Mountains, more than 525 miles west of the Missouri river. The earth is now called upon more earnestly than ever before to yield up her treasures of gold, silver, copper, iron, and mineral fuel, and the existence of the last two minerals in the west, in workable quantities, is one of the most important practical questions of the day. It is my purpose in this article, merely to state briefly some observations made last autumn in regard to the lignite deposits of Colorado and Dakota territories. The details will be given more fully in the final report of the Geological Survey of Nebraska, now in progress of preparation.

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[*] *Abstract from forthcoming Report of U. S. Geological Survey of Nebraska.*

The discovery that large deposits of "stone coal," as it is often called by travelers, existed in various portions of the west is by no means a new one, at the present time. The lignite beds of the Upper Missouri were noticed by Lewis and Clark, 1803 and 1804, those of Laramie Plains by Fremont, 1842, and those of the Raton Mt. region by General Emory, as far back as 1848. But the intense interest with which they are regarded now, as a source of fuel to the vast stretch of fertile but almost treeless plains, has been created anew by the advancing westward wave brought about by the construction of those great national highways. The fact, also, that the coal deposits of Iowa and Missouri are restricted in area and the coal limited in quantity, and in most cases inferior in quality, and that west of these states it may be said that there is no true coal at all, renders any source of fuel in the far west, a matter of the greatest importance. In the valley of the Missouri river and the Yellowstone, there are numerous beds of Tertiary lignite, varying from a few inches to seven feet in thickness. These formations have been described many times, and until the northern Pacific R. R. is carried through that region, they will remain of little practical importance. But the U. P. R. R. is now in progress of construction through the lignite deposits of the Laramie Plains, and the U. P. R. W. E. D., and the branch from Denver to Cheyenne City will pass through those of Colorado, so that if the lignite beds and iron mines of this region are of such a character as to be of economical use, the time for their demand has already come.

My examination of the geology of the State of Nebraska, during the past season, failed to develop any workable beds of coal within the limits of that state. My attention was then directed to the great lignite deposits of the Laramie Plains. I found the lignite to be of excellent quality in beds from 5 to 11 feet thick, and I estimated the area occupied by this basin at 5,000 square miles. Its most eastern limit is about 10 miles east of Rock creek, a branch of the Medicine Bow river. Outcroppings have been seen all along Rock creek, Medicine Bow, on Rattlesnake Hills, on the North Platte, Muddy creek, all along Bitter creek, Hams' Fork, Echo Cañon, and all along Weber river, nearly to great Salt Lake, showing that one connected series of deposits covers this whole area. The lignite taken from the beds on Rock creek is from the outcroppings, yet it burns with a *bright red flame, giving* out a good degree of heat, leaving scarcely any ash, and is quite as desirable fuel for domestic purposes as any wood. Indeed it might be called condensed dry wood. It is non-bituminous, exhibits just a trace of sulphuret of iron, which decomposing gives a rusty reddish appearance to the outcrops, and there are seams of jet one to twelve inches in thickness, which looks much like cannel coal and is thus termed by the miners. The Union Pacific Rail Road will pass directly through these great coal fields, and as most of the freight will go westward for many years, the cars on their return can be loaded with this lignite, thus to be distributed through Nebraska at a cost much less than that of wood at the present time. There are also indications of an abundance of iron ore in the vicinity of these deposits, and the U. P. R. R. Co. contemplate establishing rolling mills in the Laramie Plains at no distant period.

The next point visited was South Boulder creek, the Marshall mines, which are probably the most valuable in the west. I made a pretty careful examination of these mines, as they have been wrought for four or five years. An average of 50 tons is taken from this place daily and sold at Denver, at prices varying from 12 to 15 dollars per ton. The beds are at the foot of the mountains and dip to such an extent as to expose the whole series, 11 in number, varying from 5 to 13 feet in thickness, so that we have from 30 to 50 feet at least of solid lignite. This is the most favorable locality for studying the strata inclosing the lignite that I have ever met with in the west, and this is due to several causes, the principal of which is their proximity to the base of the mountains, by which they are elevated at a moderate angle. The following somewhat remarkable section is approximately correct at least.

45. Sandstone, gray and rather coarse grained.
44. Drab clay.
43. Lignite.
42. Drab clay.
41. Lignite.
40. Drab clay.
39. Sandstone.
38. Drab clay.
37. Lignite.
36. Drab clay.
35. Sandstone.
34. Drab clay, 10 to 12 feet.
33. Sandstone.
32. Drab clay.
31. Lignite.
30. Drab clay.
29. Sandstone,
28. Drab clay passing up into sand, 3 feet.
27. Lignite, 5 feet.
26. Drab clay, 5 feet.
25. Sandstone, 14 feet.
24. Drab clay, 3 feet.
23. Lignite, 7½ feet.
22. Drab clay, 5 feet.
21. Sandstone, 20 feet.
20. Drab clay, 3 feet.
19. Lignite, 7 feet.
18. Drab clay, 3 feet.
17. Sandstone, 40 feet.
16. Drab clay, 3 feet.
15. Lignite, 5 feet.
14. Drab clay.

13. Sandstone.
12. Drab clay.
11. Lignite.
10. Drab clay.
9. Sandstone.
8. Drab clay.
7. Lignite, 5 feet.
6. Drab clay.
5. Gray and yellowish gray sandstone.
4. Drab clay, 3 feet.
3. Lignite, 11 to 13 feet.
2. Drab clay, 4 feet.
1. Fine yellowish grit indurated.

Cretaceous beds, 1, 2, 3, 4, &c.

The thickness of the beds is given when it could be obtained with any degree of accuracy. It is barely possible that beds 6 to 13 feet inclusive have been broken down from the summit of the upheaval just beyond and thus displaced. The inclination of the strata from 1 to 16 inclusive is 8° east, and the cleavage of the beds of lignite is vertical and exactly parallel with the dip. From 13 to 29, inclination is 40°, and the remainder, 35°. Lignite beds 38 and 42 have not yet been tested and very little is known of them. They have been exposed in the search for iron ore. The summit of the hills above all these beds in the section is covered with a large thickness of superficial drift material, which undoubtedly conceals many other beds which properly belong to the section. Mines have been opened on Coal creek, 3 miles south of Marshall's mines, but they have been abandoned for the present. Another has been opened about 20 miles south of Cheyenne City, on Pole creek. The drift began with an outcropping of about 4 feet 8 inches in thickness, inclination 12° east. The lignite grows better in quality as it is wrought farther into the earth, and the bed, by following the dip 200 feet, is found to be 5 ft. 4 in. thick, and the lignite is sold readily at Cheyenne City for $25 per ton. The beds are so concealed by a superficial drift deposit, that it is difficult to obtain a clearly connected section of the rocks. A section across the inclined edges of the beds eastward from the mountains is as follows:

7. Drab clay passing up into areno-calcareous grits composed of an aggregation of oyster shells, *Ostrea subtrigonalis*,	
6. Lignite,	5 to 6 feet.
5. Drab clay,	4 to 6 "
4. Reddish rusty sandstone in thin laminæ,	20 "
3. Drab arenaceous clay, indurated,	25 "
2. Massive sandstone,	50 "
1. No. 5 Cretaceous apparently passing up into a yellowish sandstone,	

The summit of the hills near this bed of lignite is covered with *loose oyster shells,* and there must have been a thickness of 4 feet or more, almost entirely composed of them. The species seems to be identical with the one found in a similar geological position in the lower lignite beds of the Upper Missouri near Fort Clark, and at the mouth of the Judith river, and doubtless was an inhabitant of the brackish waters which must have existed about the dawn of the Tertiary period in the west. No other shells were found in connection with these in Colorado, but on the Upper Missouri well known fresh-water types exist in close proximity, showing that if it proves anything, it rather affirms the Eocene age of these lower lignite beds. These lignite beds are exposed in many localities all along the eastern base of the mountains, and from the best information I can secure, I have estimated the area occupied by them north of the Arkahsas river at 5,000 square miles. According to the explorations of Dr. John L. LeConte during the past season, which are of great interest, these same lignite formations extend far southward into New Mexico on both sides of the Rocky Mountains. Specimens of lignite brought from the Raton mountains by Dr. LeConte, resemble very closely in appearance and color the anthracites of Pennsylvania. It is probable that no true coal will ever be found west of longitude 96°, and it becomes therefore a most important question to ascertain the real value of these vast deposits of lignite for fuel and other economical purposes. Can these lignites be employed for generating steam and smelting ores? In regard to the lignites in the Laramie plains, I have as yet seen no analysis, but specimens are now in the hands of Dr. Torrey of New York, for that purpose; specimens from Marshall's mine on South Bolder creek were submitted to Dr. Torrey by the U. P. R. R. Co. for examination, with the following result:

Water in a state of combination, or its elements,	12·00
Volatile matter expelled at a red heat, forming inflammable gases and vapors,	26·00
Fixed carbon,	59·20
Ash of a reddish color, sometimes gray,	2·80
	100·00

A specimen from Coal creek, 3 miles south, yielded similar results.

Water in a state of combination, or probably its elements as in dry wood,	20·00
Volatile matter expelled at a red heat in the form of inflammable gases and vapors,	19·30
Fixed carbon,	58·70
Ash consisting chiefly of oxyd of iron, alumina, and a little silica,	2·00
	100·00

The percentage of carbon is shown to be in one case, 59·20, and in the other, 58·70, which shows at a glance the superiority of the western lignites over those found in any other portion of the world. Anthracite is regarded as so much superior a fuel, on account of the large per cent of carbon, and also the small amount of hydrogen and oxygen. The bituminous coals contain a large percentage of hydrogen and oxygen, but not enough water and ash to prevent them from being made useful, but the calorific power of lignite is very much diminished by the quantity of water contained in it, from the fact that so valuable a portion of the fuel must be used in converting that water into steam.

The day of my visit to the Marshall coal mines on South Boulder creek, 73 tons of lignite were taken out and sold at the rate of $4 a ton at the mine, and from $12 to $16 at Denver. This lignite is somewhat brittle but has nearly the hardness of ordinary anthracite, which it very much resembles at a distance.

In some portions there is a considerable quantity of amber. I spent two evenings at Mr. Marshall's house, burning this fuel in a furnace, and it seemed to me that it would prove to be superior to ordinary western bituminous coals and rank next to anthracite for domestic purposes. Being non-bituminous it will require a draft to burn well. It is as neat as anthracite, leaving no stain on the fingers. It produces no offensive gas or odor, and is thus superior in a sanitary point of view, and when brought into general use, it will be a great favorite for culinary purposes. It contains no destructive elements, leaves very little ash, no clinkers, and produces no more erosive effects on stoves, grates, or steam boilers, than dry wood. If exposed in the open air it is apt to crumble, but if protected it receives no special injury. Dr. Torrey thinks there is no reason why it should not be eminently useful for generating steam and for smelting ores.

Throughout the intercalated beds of clay at Boulder creek and vicinity are found masses of a kind of concretionary iron ore, varying in size from one ounce to several tons in weight. This iron ore is probably a *limonite* commonly known under the name of brown hematite or brown iron ore. It may perhaps be found in the state of carbonate of iron when sought for beyond the reach of the atmosphere. These nodules or concretionary masses, when broken, show regular concentric rings varying in color from yellow to brown, looking sometimes like rusty yellow agates. It is said to yield 70 per cent of metallic iron. The first smelting furnace ever erected in Colorado, was established here by Mr. Marshall, and he informed me that for the production of one ton of pig iron, 3 tons of the ore, 200 pounds of limestone, and 130 to 150 bushels of charcoal are required. Over 500 tons of this ore have been taken from this locality and the area over which it seems to abound cannot be less than 50 square miles. Indications of large deposits of iron ore have been found in many other localities along the line of the Pacific Rail Roads, and if the mineral fuel which is found here in such great abundance can be made useful for smelting purposes, these lignite and iron ore beds will exert the same kind of influence over the progress of the great west that Pennsylvania exerts over all the contiguous states. When we reflect that we have from 10,000 to 20,000 square miles of mineral fuel in the center of a region where for a radius of 600 to 1,000 miles in every direction there is little or no fuel either on or beneath the surface, the future value of these deposits cannot be over-estimated.

The geological age of these western lignite deposits is undoubtedly Tertiary. Those on the Upper Missouri have been shown to be of that age both from vegetable and animal remains, and in the Laramie Plains I collected two species of plants, a *Populus* and a *Plantanus*, specifically identical with those found on the Upper Missouri. The simple fact that Cretaceous formations Nos. 1, 2, 3, 4 and 5, are well shown all along the foot of the mountains, and that No. 5 presents its usual lithological character with its peculiar fossils, within 15 miles of Marshall's mines, also that at the mine, 2, 3 and 4, are seen inclining at nearly the same angle and holding a lower position than the lignite beds, is sufficient evidence that the strata inclosing the lignite beds are newer than Cretaceous. A few obscure dicotyledonous leaves were found, which belong rather to Tertiary forms than Cretaceous.

The connection of the lignite deposits on the Upper Missouri has been traced uninterruptedly to the North Platte, about 80 miles above Fort Laramie.

They then pass beneath the White river Tertiary beds, but reappear again about 20 miles south of Pole creek, and continue far southward into New Mexico. Near Red Buttes, on the North Platte, it seems also probable that the same basin continues northward along the slope of the Rocky Mountains nearly or quite to the Arctic sea. Whether or not there are any indications of this formation over the eastern range in the British possessions, I have no means of ascertaining, but the Wind river chain, which forms the main divide of the Rocky mountain range, exhibits a great thickness of the lignite Tertiary beds on both eastern and western slopes, showing conclusively by the fracture and inclination of the strata, that prior to the elevation of this range, they extended uninterruptedly in a horizontal position across the area now occupied by the Wind river chain. Passing the first range of mountains in the Laramie plains, we find that the Big Laramie river cuts through Cretaceous beds, Nos. 2 and 3, continuing our course westward to Little Laramie, a branch of the Big Laramie, and No. 3 becomes 50 to 150 feet in thickness filled with fossils, *Ostrea congesta*, and a species of *Inoceramus.* At Rock creek, about 40 miles west of Big Laramie river, the lignite beds overlap the Cretaceous, but in such a way as to show that the more inclined portions have been swept away by erosion, and that the red beds and Carboniferous limestones once existed without break and in a horizontal position across the Laramie range prior to its elevation.

I cannot discuss this matter in detail in this article, but the evidence is clear to me now, that all the lignite Tertiary beds of the west are but fragments of one great basin, interrupted here and there by the upheaval of mountain chains or concealed by the deposition of newer formations.

All the evidence that I can secure seems to indicate that there are no valuable beds of lignite west of the Mississippi, in formations older than the Tertiary.

POSTSCRIPT.

After my article on the Lignites of the West was in type, Professor Lesquereux sent me the following very valuable notes, as the result of his preliminary examination of the fossil plants of the Lignite deposits. His conclusions seem to confirm my statements that all these formations are probably of Tertiary age.

Species from Rock creek, Laramie Plains.

1. *Populus attenuata* Al. Braun. The identity of these leaves with the European species is undoubted.
2. *Populus lævigata*, sp. nov., related to *P. balsamöides* Göpp., a species, which, like the former, is abundant in the Miocene of Europe.
3. *Populus subrotunda*, sp. nov. Type of neuration of *P. melanaria* Heer, and form of leaves of *P. mutabilis* Heer, both species also common in the Miocene of Europe.
4. *Quercus acrodon*, sp. nov., a fine oval leaf resembling a chestnut leaf, related to *Quercus prinoides* Wild, of our time.
5. *Quercus Haydeni*, sp. nov., lyrate leaf with lobes strongly dentate, without near relation to any species, either of the Tertiary or of our time.

6. *Platanus aceroides* Göpp., one of the most common species of the Miocene of Europe. It is closely related to, if not identical with *P. occidentalis L.*, of our time.

Marshall's mine (near Denver).

1. *Quercus chlorophylla* Ung. Three specimens of this species have been figured and described in my paper, "On species of fossil plants from the Tertiary of Mississippi" (Trans. Phil. Soc., vol. 13, pl. xvii, fig. 5, 6, 7). It is still uncertain if these leaves represent a *Quercus*, but all belong to the species described and figured by Heer under this name, and common in the whole thickness of the European Miocene.
2. *Quercus Lyelli* Heer, also figured in the above paper, pl. xvii, figs. 1, 2, 3. Though the specimen is somewhat obscure, the essential characters which distinguish the species are well discernible. It is abundant in the Bovey Tracy lignite formations of England, Lower Miocene.
3. *Cinnamomum affine*, sp. nov. This species is also found at Raton pass. The leaf from Raton pass is smaller and might belong to a different species, but except the size I do not find ground for separation: very near *C. Mississippiensis* Lesq., and also closely related to *C. Buchi* Heer, of the Lower Miocene of Europe.
4. *Cornus incompletus*, sp. nov. A part of a leaf apparently round at the top, general outline uncertain. It is figured merely for future reference. By its peculiar nervation this leaf appears in close relation to, if not identical with *Cornus rhamnifolius* Web. Pretty common in the lower Miocene of Europe.
5. There are, in the Marshall's shales, a few fragments of Maple leaves (*Acer*) specifically undeterminable, and also one winged seed of this genus. This seed has a narrow straight wing like that of *Acer trilobatum* Heer, but with smaller nutlet.
6. *Rhamnus salicifolius*, sp. nov., in soft sandstone; related to *R. marginatus* Lesq., and also to *R. Carolinianus* Walt., now living and abundant in southern swamps.
7. *Juglans rugosus*, sp. nov., very nearly related to *J. acuminata* Al. Braun, a species extensively distributed in the European Miocene.
8. *Echitonium Sophiæ* Web. The leaf has no visible nervation, but it is exactly like both the forms represented from European specimens. It is found in the whole Miocene of Europe, especially in the lower stage.
9. *Phyllites sulcatus*, sp. nov. The borders of the leaf are destroyed, but the nervation is quite peculiar. It is referable either to a *Rhodora* like *R. Canadensis* of our time, or represents merely the lower part of the winged petiole of the fruit of a Linden (*Tilia*).
10. *Lygodium compactum*, sp. nov. Though many species of Lygodiums are described from the Tertiary of Europe, none are related to ours. One lobe of a leaf only is presented, and the

general outline of the leaf is therefore unknown, but the nervation which is very close and more like that of a *Néuropteris*, is of a peculiar character.

Lignite beds near Golden City, Colorado.

1. ***Magnolia tenuinervis***, sp. nov. Not possible to indicate the general form of the leaf of which a part only is presented. Its thin and sharp secondary nerves distinguish it from any other fossil species.
2. ***Lathrœa arguta***, sp. nov. May be a ***Pecopteris***. No relation observed of any known species to this one.

Raton Pass. Specimens collected by Dr. LeConte.

1. ***Berchemia parvifolia***, sp. nov. Related to ***B. multinervis*** of the European Miocene, but still more like our ***Berchemia volubilis*** which fills the southern swamps. The basilar part of the leaf is not seen and therefore a satisfactory determination is not possible.
2. ***Abietites dubius***, sp. nov.

Most of the specimens from Raton pass have some remains of eaves or branches of a coniferous species which can be referred, perhaps, as well to the genus *Araucaria* as to *Sequoia* or *Abies*. As the leaves on the branchlets appear evidently placed around the stems and not on both sides of it, and as the scars left on the bark are of the same form as those of an *Abies*, I place these remains in this genus till they may be studied on better specimens. The leaves are pointed as in *Taxites dubius* Göpp., from the Tertiary of Europe; except this, these remains have no analogy with any other, published or figured.

3. ***Echitonium Sophiæ*** Web. A small fragment exactly like those of Marshall's coal bed and a specimen of *Cinnamomum affine* already mentioned from the Marshall's shales.

Upper end of Purgatory cañon, Dr. LeConte.

1. ***Rhamnus obovatus***, sp. nov. All the specimens are from the same place, and all contain fragments of the same species, and none of any other. This species is peculiar by the form of the leaves; it has the character of a *Rhamnus* but the secondary nerves are closer and more numerous than in any other species of the genus, even more so than in a *Berchemia*. I do not know of any fossil plant comparable to this.

From this short report on your fossil plants examined till now, it is easy to draw some general conclusions.

From Rock creek we have only six species. Two are identical with species from the Miocene of Europe, and one of them, *Platanus aceroides*, is not distinguishable from our *P. occidentalis*. Two other species are closely allied to European Tertiary species. And of the two others, one is an American type related to *Quercus* *prinoides*, still in our flora, the other a peculiar and lost type. The appearance of this florula is quite modern. This may be the result of geographical circumstances. Poplars and Buttonwoods live together in the bottoms of rivers, and therefore I may mistake in believing this Rock Creek formation more recent than that of Marshall's. In any case it is certainly Tertiary and has no plants of an older formation.

In Marshall's (coal beds) we find only ten species of fossil plants, two *Quercus* and one *Echitonium* apparently identical with Miocene species of Europe, one *Rhamnus* closely related to a living species of ours, and at the same time to a fossil species of the lignite of Mississippi, one *Cornus*, one *Juglans*, and one *Cinnamomum*, all related to Miocene species, and the last one also closely allied to a species of the Mississippi Tertiary; undeterminable leaves of Maple, seeds of the same genus, a *Lygodium* and an undeterminable *Phyllites* complete the list. These plants have, therefore, all of them, the character of Tertiary plants. The general aspect of the Marshall coal flora is that of the Mississippi lignite, which I consider as either lowest Miocene or Eocene. In this I am much pleased to find my views so well agreeing with yours.

The materials obtained from the strata of Golden City, Raton Pass and Purgatory cañon, are too scanty to permit considerations in regard to the geological positions of the strata which have furnished them. No *Abies* has yet been described from Tertiary strata, but with these broken remains of a conifer of uncertain genus, the shale of Raton Pass has a *Berchemia*, which is a Tertiary plant, and a leaf of *Echitonium*, and one of *Cinnamomum* identical with specimens found at Marshall's.

The remarks as given above, were sent to me by Mr. Lesquereux, in the form of a letter, and all the important facts contained in it are given, omitting unimportant details. I regard these results as extremely interesting, throwing much clear light on many obscure points in western geology. That the Marshall beds are lower Tertiary, may be inferred not only from the organic remains, but also from the entire conformity, so far as can be seen, of Cretaceous and lignite beds. It will be difficult also to draw any line of separation between Eocene and Miocene in the lignite formation in any part of the West.

ART. XXIV.—*Some Remarks on the recent Geological changes in China and Japan;* by ALBERT S. BICKMORE, M.A.

IN the old and accurate description of China, compiled by du Halde in about the year 1725, from the full diaries and journals kept by the Jesuits, who between 1708 and 1717 traveled over and mapped out all that vast empire, I find these noteworthy remarks on the changes in the physical geography of China, since her earliest history.

"In the abridgment of Chorography entitled Kwang-iu-Ki, we find that the city Chantsien (the capital of Corea in 1694), where Kipe (the king of Corea at that time) resided, is in the territory of Yungping fu, a city of the first order in the province of Pechili."

"Now, supposing this to be true, one may reasonably conclude that the ancient Chantsien and Corea were *contiguous*, and not separated by a gulf till many ages after. For it is not to be imagined that a prince would fix his residence out of his dominions, especially if divided from them by a wide sea. This conjecture will appear the more probable if we carry our speculations a little higher (i. e., to a more ancient period).

"When Yu (whose memory is justly honored by the Chinese with the title of great) undertook to drain the waters, which under the reigns of Shun and Yan had overflowed the flat country, he cut a passage for the river Hwang Ho (or Hoang Ho), i. e., the Yellow river, through a mountain on the southern boundaries of Shansi and Shensi, which provinces that river separates, and makes a cataract here not inferior to those of the Nile. Thence he conducted it through the province of Honan, and following its channels along the province of Pechili, he drained the lake Talu (i. e., Pehlu) into which the Hwang Ho formerly emptied itself. This lake overflowed all that country which now includes the districts of Shunti fu, and Chauchau and Sinchau in the same province. At last to break its rapidity, he divided it into nine channels, which some imagine were again united before it disembogued itself into the sea. But whether they were joined, or if it was only the main channel that ran into the sea at the foot of the mountain Ki-she-shan, which was then made a promontory, this is certain, that since Yu began that great work (about 3921 years ago), this river *has* strayed so far from its ancient course; for instead of discharging itself into the sea as it did formerly in lat. 40° it now falls into the river Hwang Ho, a little above Hwaingan, a city of the first rank in the province of Kiangngan about lat. 34°.

It is likewise observable, that the mountain Ki-she-shan, which formerly was united to the territory of Yungping fu, is now *five hundred* li (*about one hundred and sixty English miles*) distant in the sea from this city (and now, 1867, it probably forms one of the islands near the promontory north of the Miautau islands). So that the sea gaining on the land by degrees has at last overflowed all this tract of ground. It is indeed true that the Chinese history makes no mention of this extraordinary change of the course of the Hwang Ho, nor of this overflowing sea. But when alterations on the surface of the globe are brought about insensibly, and without alarming nature, they easily escape the observations of history, the difference that happens during the life of one man being not at all perceptible."

In October, 1866, after a long journey through the southern and central part of China, from Canton to the Tungting lake, and down the Yangtse to Haukow and Shanghai, I took passage for Tientsin through the kindness of my good German friends Trautmann & Co., on their steamer, the "Nanzing." My object in part was to note what evidences might appear of recent geological changes in the plain of Pechili, and to visit the coal mines near the capital of the empire. From Tientsin I proceeded directly to Peking, and thence to the mountains on the north, and along the flanks of this range to the Nankau pass, and thence to the coal mines, a day's journey southward. And in entire accordance with Father du Halde's statements and speculations given above, everywhere there appeared evidences of a recent elevation above the sea. A consideration of the charts of the gulf of Pechili and the Yellow sea, farther showed me that the true eastern border of this plain is not the present sea shore, but that this plain *continues out under* the gulf and under the Yellow sea, on the north to Corea, and on the south of Shantung even to the Japanese Islands, the Lew Chews and Formosa. In other words, this plain extends out eastward to the mountain range which stretches along the proper eastern edge of the Asiatic continent, the true Pacific basin beginning only eastward of the islands just named.

If the north of China were to be raised but one hundred and twenty feet, the whole gulf of Pechili would become *dry land*, and if it were elevated as much more, in place of the Yellow sea there would be a continuous plain from Peking to Corea, and *such* a change is now actually going on. At Chefoo, on the northern side of the promontory of Shantung, there is a long sand-pit extending out from the mainland to a high headland, and forming the western side of the harbor. On this *spit* are seen two old sea beaches, as perfect as the present one.

The highest is but a few feet above the sea, yet it shows what kind of a change the surrounding area has recently undergone, and this is farther strengthened by the testimony of all the Chinese, that "the harbor is slowly filling up."

It is seldom possible to obtain data that will give us the rate of such changes, and therefore the following statements kindly furnished me by the Rev. Mr. Metier at Tungchau, are the more valuable.

"I have learned with some degree of probability that in the Ming dynasty, some 250 years ago, the water from the sea came up the bed of what is now a small creek, past the city, and extending as much as three li (one mile) from the present beach. I also learned that at that time, the water in the basin of the "Water city," was at least *fifteen* Chinese feet deep where now it is not *three* feet deep. This difference of twelve Chinese (14$\frac{1}{10}$ English) feet is the *least* that will account for the water running up to where it is said to have done. At a later date, the water came up outside the water city to the bridge near a li (one-third of a mile) from its present beach. The decline has been so gradual, that there is now no way of telling exactly when the junks quit coming. It is said that there was originally no dry land in the water city, save the very least close to the wall. It was built by a man named Chi, as a depot for the government junks, and was not intended to include any place to build upon, but to be a safe depot, where pirates could not come."

This elevation of at least 14$\frac{1}{10}$ English feet in 250 years, gives a mean rate of nearly five feet in a century, and to realize the whole elevation of the bed of the gulf of Pechili, we must add to this rising, an estimate of the quantity of sediment probably brought down by the Yellow river, the Peiho and minor streams.

If this area had subsided 14 feet during the last two centuries and a half, instead of rising 14 feet, of course it would have been 28 feet below its present level, and probably *one-third of the low, thickly populated parts of China would then be beneath the sea.*

About Peking the plain of Pechili is composed of stratified clays, that form in the dry weather a fine, light dust, from two to five inches deep. When the heavy winds of autumn and winter set in with violence, this dust rises in one continuous mass to the very clouds, and forms the dust storms for which Peking is so justly famous.

As I journeyed over the plain, I noticed in many places considerable quantities of clay stones closely resembling branching corals, for which, indeed, they have been mistaken. But instead *of being of marine origin,* they are formed by the water trickling down along the grass roots, which in this way receive a series of concentric layers from the surrounding clay. And as the water follows the various branches of the roots, these clay stones necessarily take a branching form. Frequently, where the strata have not been disturbed, these roots can still be seen with the concretions around them.

In the Nankau pass, and for some distance about the place where it opens out to the plain, there appear large quantities of transported boulders. These were probably borne near to the places they now occupy by an old glacier that once filled up this pass, and brought them down from the neighboring mountains, or perhaps even from the southern borders of the high plateau of Mongolia, on which this river of ice probably took its rise. But a short distance from the mouth of the pass, in every direction over the plain, these boulders completely disappear. Many of them have been gathered by the farmers to make walls of their houses, but as few are to be seen in the clay banks, the question naturally arises, whether the materials that now fill the Peking basin have not been so completely sorted and resorted by the action of the waves as the land has rose and sunk from the level of the sea, that the larger boulders are mostly resting on the rocky floor of the basin, or at least at a considerable distance below the present surface of the ground.

As we followed the flanks of the mountains, southward, we came to a remarkable depression in the plain, evidently the bed of a lake that had recently been drained off, not over the plain toward Peking, but through some rent in the mountains toward the west, into the present channel of the Yang Ho, and along the course of this river to the gulf of Pechili. Farther down the Yang Ho, a small stream comes in on the southwest from a valley where are located the coal mines of Mun-to-kow. This minor valley is bordered with a terrace of 40 or 50 feet in height. Besides these evidences of the late presence of the sea in this region, I was shown at Peking, some shells from banks in the vicinity, and I believe they were all of the same species as are now to be found in the gulf of Pechili.

All these changes have occurred without especially attracting the notice of the people, but it has been far otherwise with the Yellow river, whose irregular wanderings and destructive floods have gained for it the well merited title of "China's sorrow."

All rivers after they have worn out their channels to a certain depth, have a tendency to deposit in their own beds a part of the mud and sand they are bearing along, and this tendency is greatly increased by preventing them from overflowing their banks by artificial levees or dikes. The Po in this way has raised its bed until the surface of its water is above the tops of the houses of the peasants, and it has already once deserted its old channel and formed a new one, and this is in short the whole history of the Yellow river. When it had filled up tis old channel to the south of Shantung, and succeeded in making a breach through its artificial banks, it followed very nearly its previous course north of Shantung to the gulf Pechili. The whole plain through which it flows in the lower part of its course being of alluvial origin, and completely intersected by streams and canals, its waters would readily find a lower channel which their momentum in coming down from the higher level of their old bed would enable them to quickly enlarge. The elevation of the land along the sea coast at the rate of five feet a century, would have a tendency to render its current more sluggish, and consequently the quantity of sediment deposited in its own bed, greater than if it remained stationary or was somewhat subsiding. But this tendency may have been partially counteracted by an equal or greater relative elevation of the area along its upper course, and it is perhaps worth remarking in this connection, that one of the latest changes that has taken place where the Asiatic continent joins that of Europe has been one elevation and that the Aral Sea, and the lakes east of it being merely remnants of one great internal, depressed sea, whose bed has probably undergone a considerable elevation.

The last change in the course of the Yellow river occurred when the Taiping rebels were approaching and threatening Peking, and is supposed to have been caused by a breach made either by them, or as is more probable,.by the Imperialists, to arrest the progress of their formidable enemies. All accounts agree that this change is complete and that its old bed is dry, but this is merely another way of stating as fact what has just been assumed, namely, that the river continued in its old channel until that had become as high or higher than the surrounding country.

Dr. Martin of Peking informs me it now leaves its old channel a short distance below the city of Ifung, and passing northerly near Tsau-chau and Poh to Fam, it flows in a northeasterly direction to Tungping, and thence to Tsinan fu, the capital of Shantung, and down the bed of the Tatsing river to the gulf of Pechili. This course is just about at a right angle with the old one to Hwaingan; and the distance from its present mouth to where it emptied before into the Yellow sea is more than 380 miles in a straight line and more than twice that distance along the sea shore. Perhaps we can better appreciate how great a change this must have been, if we suppose that at some time the *Mississippi, on reaching* the city of Natchez, should suddenly desert its old channel to the Belize, and taking a more easterly course, pour out its waters into Mobile bay.

Probably no other river within historic time has wandered so far and so frequently from its old channels as this Yellow river, but also probably, no other river on the whole globe flows out on to a plain of such wide extent at right angles to its own course, and at the same time of such a perfect and continuous level. The Imperial or Grand canal indicates how remarkably low and how uninterruptedly level the surface of this plain must be. No other country has ever had such an artificial water communication, but what other has such wondrous natural facilities for one of such a length, and like this at right angles to the courses of its two greatest rivers? While the Mississippi, the Ganges and the Nile flow out through many mouths, the Hwang Ho now confines itself to one, though a part of its waters appear to escape southward through the Imperial canal.

Farther southward, the region about the mouth of the Yangtse Kiang has also been lately raised, though it may now be in a state of rest. This change is clearly shown by the bank of recent shells, described by Dr. Lamprey in his paper on the "Geology of the Great Plain."

The mouths of the Yangtse themselves have changed greatly, and Tsung Ming island, which now has a population of *half a million*, did not *exist* in the fourteenth century.

The Tunting and Poyang lakes, which act as immense reservoirs for this river, receiving a part of its surplus waters during the floods and pouring them out again during the dry season, are slowly filling up with the sediment brought into them by their streams on the south. It has been noticed, that near each of these lakes high mountains appear. This fact probably indicates the origin of their basins, for they are merely the lowest parts of large depressions, and where the strata have been so folded that the crest of the undulation is remarkably high, the depression of that undulation must be correspondingly low. This is what has occurred where these lakes and their neighboring mountains have been formed. On my way through the interior of China I crossed Tungting lake, and found its waters to be quite shallow, and that they spread out widely over the low, swampy lands along its southern shores in the time of the floods. When I reached Siangyin, I found the whole adjoining country overflowed, and that we were already standing by the lake, although according to the map, it ought to have been dry land for more than *twenty miles* farther.

The basins of these, and the other lakes scattered over the *great* plain, may be places of a slight local subsidence, but it is far more probable that they are small areas not yet filled up with the alluvial deposits of which the whole plain is composed, and which has been brought down from the mountains mostly by the Yellow river and the Yangtse.

At Foochow and about the mouth of the river Min, I believe there is an area that has for some time been slowly subsiding. While all the other rivers in China flow out through a low delta, that they have formed themselves, the Min at once empties itself into the sea; no delta is seen, yet the Min *has* one, as much as the Peiho, the Yellow river, the Yangtse, the Tsientang by Hanchau and the Sikiang by Canton. Its delta consists in the small and dangerous banks about its mouth, and if the deltas of these other rivers were to subside as fast as, or faster than they are raised by the deposit of sediment over their surfaces, each would present a phenomenon strictly analogous to that of the Min. When I visited Fóochow, I noticed these indications of a late subsidence, and Mr. Dunn, of Hedge & Co., kindly gave me these corroborative facts. In digging a well in their compound, "at a depth of from twenty-five to thirty feet below the surface of the ground, there were found two boards about four or five feet long and one foot wide, nailed at the ends to a post. At the same depth was found a quantity of broken crockery of the same kind as that now used by the lower classes of Chinese, and a number of pieces of half-decayed wood. The earth in which these things were found was a rather loose mixture of mud and sand, bearing a close resemblance to what is now seen along the river banks at low water. The impression upon my mind at the time, was that we had struck the remains of a Chinese house, and the workmen were of this opinion. The tide here has a rise of about 12 feet at high springs, which would place the post *about twelve feet* below the present *low water level.* According to the Chinese, what is now the navigable branch of the river (i. e., between the city and the foreign settlement) was some 900 years ago too shallow for junks and large boats. The south branch was then in general use. The long bridge at the head of the island (opposite the city of Foochow), and the remains of dikes and flood gates in that vicinity, lend an air of probability to this statement."

In the plain about Foochow, as indicated above, the river Min frequently changes its bed by washing away one bank and building up the opposite one. And at the foreign settlement a number of lines of stakes are placed in the edge of the river to catch this changing sand and clay, and gain land on that side. At first it might appear that this post with its boards had simply sunk *on one* side of the river channel and been covered by the sand mud from the opposite bank, but the fact that it appeared to be a part of a house, and was found with pieces of crockery ware, shows it had probably not floated to the place where it was found. The simple fact that *twenty-five* feet of sand and mud had been deposited over these works of human hands, proves in itself their high antiquity, as plainly as in the case of the canoes taken out from a depth of twenty feet beneath the streets of the city of Glasgow.

In the south of China, Dr. Legge informs me that along the East river, he has seen a large bank of shells filled with specimens of shells which he believes will prove to be of living species.

Passing from the continent to Formosa, Mr. Swinhoe informs me that Castel Zelandia, a fort built by the Dutch in 1634, on what was then an island, is now some distance back from the river and in the *center* of the city of Taiwan fu; also that at Takao, recent crabs and recent shells are found at a height of 1,111 feet above the present level of the sea.

During my travels in the north of China, I came to Chefoo on the northern side of the promontory of Shantung, and Capt. Shufeldt, of the U. S. ship Wachusett, kindly took me over to the mouth of the Tatung river, near Sir James Hall's Islands on the west coast of Corea. That river was found to debouch into a large bay, and along the northern side of this bay is a gradually ascending plain, from which a mountain range rises up abruptly. An indication of the recent period in which this plain must have been raised above the sea, is seen in the fact that all the streams that flow over it from the valleys among the neighboring mountains have as yet only worn out for themselves shallow beds in the loose soil. The height of this elevation I estimate at from 300 to 500 feet.

Passing over to Niphon, we find on the western side of the bay of Yedo, a plateau some 200 feet high, its top as level as if made by the hand of man. A short journey from Yokohama back to Kanasawa, hence across to the bay of Kamokura, and up the Tocaido to Kanagawa, showed me that all this area is also of very recent marine origin. The highest place we passed over I judged to be from 500 to 600 feet above the present level of the ocean, but terraces up to twice that height will probably be found among the neighboring mountains. Most of the "hills" in this region have been formed by the streams washing out gulleys in the plateau. These have enlarged into valleys, and these again have widened until only sharp ridges are left of the once continuous plain.

In the bay of Kamokura is the island Inosima. At present it is connected to the main land by a sand spit, about half a e long, two hundred to five hundred yards wide, and from to five feet above high water level. This I suspect is the nd mentioned under the name of Kamokura, by Kaempfer, he year 1691, while on his way from Nagasaki to Yedo. describes it as follows:* "Off the shores of the outer bay Jedo, was seen the Island of Kamokura, with high rugged res, but of which the surface was flat and wooded. It was above four miles in circumference, and was used like several er islands, as a place of confinement for disgraced noblemen. ere being *no landing-place*, the boats that carry thither soners or provisions must be hauled up and let down by a ne."

North of Niphon, on the island of Yesso, terraces line the thern shore of Tsugar strait and Volcano Bay, and what already been described in Corea, again appears there, but a much grander scale. The greatest height to which I have n able to trace the recent action of the sea, is 1,180 feet. is was found on the flanks of the mountains north of Haladi, but when foreigners are allowed full liberty to travel ere they please over the Japanese Islands, similar phenomena l undoubtedly be found at a still greater height.

As I passed up the gulf of Tartary, I touched twice on the tern shore of the island of Saghalien, and continued to find aces to a considerable height. Again, the village of Nikosk, at the mouth of the Amoor River, is situated on a bluff t appears to have been recently elevated from 30 to 50 feet ve the present level of the river.

All these facts considered in connection with the dry beds of hs and bays along the Siberian borders of the Arctic ocean, l the remnants of the old gulf that once washed the eastern nks of the Ural, give us some idea of how the Asiatic continent has increased her area within the later geologic times.

T. XXIV.—*On the Palæotrochis of Emmons from North Carolina;* by Prof. O. C. MARSH, of Yale College.

IN 1856, Prof. E. Emmons announced the discovery, in the ver "Taconic" rocks of North Carolina, of some peculiar sil corals, which he regarded as the oldest representatives of animal kingdom on the globe. Believing them to indicate ew genus, he proposed for it the name of *Palæotrochis*, and ve a description and figures of two varieties which he considered specifically distinct.* The forms described were found in Montgomery county, where they occur in great abundance in granular quartz and slaty quartzite, having a vertical range of about 1,000 feet. Prof. Emmons attached great importance to the fact that they occur in auriferous rock, and he hence inferred that the gold must have been deposited as a sediment. Shortly after the description of *Palæotrochis* was published, Prof. James Hall, in a letter to Prof. Dana, suggested that these forms were merely concretions, an opinion subsequently controverted by Prof. Emmons, who maintained their organic character.†

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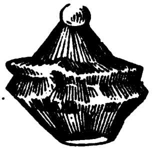
* Vide Hildreth's Japan as it was and is, p. 357.

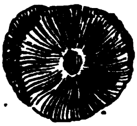
These supposed corals are usually lenticular in form, often resembling two short cones placed base to base. In size, they vary from one-fourth of an inch to two inches in diameter. The exterior is covered with irregular striæ or grooves, which extend from apex to apex. Many of the smaller specimens have at one extremity a rounded knob, and at the other a cavity.

The following figures, from Prof. Emmons' Report, represent the more common varieties, and are here repeated for convenience of reference.

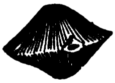
1.



2.



3.



While making some investigations during the past summer on the structure known as "cone in cone," the writer's attention was called to these peculiar forms, and their inorganic nature was at once suspected. An examination of the interior of several specimens clearly indicated that they were not corals, and, as soon as microscopical sections could be prepared, they were more carefully examined, but no trace of organic structure could be detected, the entire mass being evidently a finely grained quartz. The specimens examined were undoubtedly authentic examples of *Palæotrochis*, as some of them, presented to the Yale cabinet by Prof. Dana, were sent to him by Prof. Emmons, and the rest were given to the writer by Prof. W. C. Kerr, the present State Geologist of North Carolina. It follows, therefore, that this name should in future be dropped from the genera of fossils. It is not, indeed, impossible, or even improbable, that the gold-bearing rocks of North Carolina may yet be found to be fossiliferous, but up to the present time no satisfactory evidence of their being so appears to have been brought to light.

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* *Geological* Report of the Midland Counties of N. C., p. 62. Also this Journal, *vol.* xxii, p. 389.

† *This* Journal, xxiii, p. 278, and xxiv, p. 151.

Admitting the inorganic nature of these remarkable forms, their origin becomes an interesting question, and it certainly is not easy to give a satisfactory explanation of it. They appear, however, to have some analogy with "cone in cone," which, as the writer has shown elsewhere,* is probably due to the action of pressure on concretionary structure when forming. In some respects the two are quite distinct, but evidence of pressure is clearly to be seen in both.

If inorganic, these forms may, of course, be looked for in other formations, wherever the same conditions have existed. Prof. Newberry, of Columbia College, recently informed the writer that he once observed a somewhat similar structure in altered Tertiary rocks in Oregon. Nothing of the kind, however, except the Palæotrochis, appears to have been hitherto described.

New Haven, Ct., Jan. 25, 1868.

Art. XXV.—*On the Delta-Plain, and the Historical Changes in the course of the Yellow River;* by Raphael Pumpelly.†

The extent of the great plain of Eastern China is pretty well known from native and Jesuit authorities. It lies in a semicircle around the mountainous peninsula of Shantung. Its outer limit, as approximately given on the Jesuit map, begins in the department of Yungping (fu), and, running west, keeps south of the Great Wall till Changping (chau) N.W. of Peking. Thence, remaining east of the southern branch of the Great Wall, it follows a general S.S.W. course, passing westward of Chingting (fu), till it reaches the upper waters of the Wei River. Here it turns westward into Hwaiking (fu), and crosses the Yellow river in that department.

From the right bank of this river it trends a little east of south, passing west of Jüning (fu) (Honan), and then turning eastward it continues south of Kwang (chau) and north of Luhngan (chau) in Luchau (fu). Here an arm of the plain, in which lies the Tsau lake, stretches southward from the Hwai river to the Yangtse, and continues eastward on the right side of this river, occupying the region between the river and Hangchau bay. A hilly region, in the center of which is Nanking, rises, like a large island from the plain, to the north of this arm.

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* Am. Association of Science, Burlington Meeting, August, 1867.

† From Geological Researches in China, Mongolia, and Japan, during the years 1862 to 1863, by Raphael Pumpelly. 144 pp. 4to. Smithsonian Contributions to *Knowledge, No. 202, 1866.*

The Shantung boundary of the plain begins at Laichau (fu), and after describing a great bow to the south it turns west at Shukwang (hien), and running thence to Changtsing (hien), in Tsinan (fu), it turns to the south and around to the southeast. Keeping this course it remains nearly parallel to the Imperial canal till the Kiangsu frontier, which it follows to the sea.

The greater part of the area included within these limits is a plain which seems to descend very gently toward the sea, and to be very generally below the high water level of the Hwang Ho. It is the delta of the Hwang Ho, and in part also of the Yangtse Kiang, and is remarkable for its semi-annular shape, half inclosing, as it does, the mountain-mass of Shantung.

The city of Peking stands on a raised border of loam, sand, clay, and gravel, which forms the northwestern skirt of the delta-lowlands, and seems to extend southward fringing the mountains along its western side. The name of the Talo lake (Ta, great, and lo, plateau or raised plain) seems to refer to such a border, and in the article on Kichau in Yukung it is said that "the Lo (plateau) was drained."[*]

The fact, also, that in historical times none of the arms of the Hwang Ho have approached the western mountain border of the plain, both north and south of Kaifung, within a less distance than from ten to fifty miles, seems to point to the existence of a recent sea margin, which would be perhaps due rather to the detritus brought down by local streams than to the delta deposit of the Hwang Ho.

All the important changes in the lower course of the Hwang Ho have been recorded from early times by Chinese historians, and their documents and maps form the most complete history we possess of the wanderings of any river.

The Yukungchuchi (Peking, 1705), written by Chin Hu Wei, contains a series of maps in which these changes are laid down for a period of more than 3000 years. M. Biot has given the substance of that part of this work that relates to the Hwang Ho, in a carefully prepared paper.[†] I have, however, thought the subject to be one of sufficient interest to warrant the reproduction of the maps of Chin Hu Wei, with such explanations as will render them intelligible, without going beyond the limits of a work that is intended to give only my own contributions to the physiography of Eastern Asia.[‡] For further information I must refer the reader to M. Biot's paper, of which I shall make use in explaining the maps.

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[*] *E. Biot*, Sur le chapitre Yukung, Journ. Asiatique, 1842.

[†] *Sur les changements du cours inférieur du fleuve Jaune*, Journ. Asiat. 1843.

[‡] *The reader will have to refer to Mr. Pumpelly's volume for these maps.*

In the Yukung, a chapter of the Shuking classic of Confucius, it is said that the course of the Hwang Ho was regulated by the Great Yu. Whether the works of Yu are to be understood as the labor of a single man, or as the results of the enterprise of a rising colony during several generations, there seems to be little doubt that more than 2000 years before the beginning of the Christian era the Chinese had brought this turbulent river under their control, by an immense system of dykes, and had begun to cultivate the extensive marshes of the delta plain.

Map No. 1 of the series, on plate 4, represents the course of the Hwang Ho as it existed, in the main, from the time of Yu down to 602 B. C.

Map No. 2 represents the course resulting from the first great change, that of the fifth year of the reign of Ting Wang (Chow dynasty), 602 B. C.

Map No. 3 serves to illustrate a passage in the writings of the poet Sse Ma Tsien, recording a diversion to the east and southeast. The easterly course, forming the Pien river, seems to have been the earliest recorded tendency of the river to follow its recent course. The opening of the first channels in this direction is given as occurring in 361 and 340 B. C.

The diversion, indicated on this map, through lake Yungtse to the southwest, happened, according to Sse Ma Tsien, toward the end of the Chow dynasty, during the third century before Christ.

Map No. 4 represents changes that occurred under Wutih (Han dynasty), about 132 B. C., when a great overflow toward the northeast took place, the river trending toward Kai (chau) in Chihli. At this time several arms were formed between Taming (fu) and the sea, which are also given. Previous to this, under Wentih, about 160 B. C., there was a breach formed at Yentsin near Kaifung.

Map No. 5 gives the second great change in the course of the "river of Yu," which occurred about 11 B. C., and was caused apparently by the blocking up of the channels leading to the Pei Ho.

Map No. 6 shows the channels as they existed during the Tang, and five succeeding dynasties, till the beginning of the Sung dynasty.

A note on the map of Chin Hu Wei says, "the course of the river remained the same from the time of Ming Ti (Tung Han dynasty) A. D. 70 . . . . . . till under Jin Tsung, A. D. 1034, when a break occurred at Hunglung, and another, fourteen years later, A. D. 1048, at Changwu, and the river of the *Han and the Tang* was entirely destroyed. The map covers a *period of 977 years.*"

Map No. 7 (Pl. 5) represents the courses, under the Sung dynasty, from A. D. 1048 to A. D. 1194, a period of 146 years.

Map No. 8 records the course during the Kin dynasty. All the former channels appear blocked up, and the river, after entering Lake Lo, near the summit-level of the present Imperial canal, is seen to flow off to the N.E. through the Tatsing river, and to the S.E. through the Sz river. Lake Lo appears from the observation of Clark Abel, and from Chinese measurements, to be about 150 feet above the sea.

Map No. 9 shows the condition of the river under the Yuen and Ming dynasties, together with the Grand canal, a condition which seems to have remained substantially the same till within the last ten or fifteen years.

In early times the Yangtse entered the sea by three arms called the Sankiang, i. e., "Three Rivers;" and Chin Hu Wei has given a map of these, founded on the opinions of early authorities. I have indicated them on map No. 1 of the series.

A glance at the nine maps of the delta courses will show how widely separated have been the limits of divergence of the arms of the Hwang Ho, within the past 3000 years. A mighty river, ever turbulent, subject yearly to an enormous increase in volume, an increase regulated rather by the amount of precipitation in the distant Kwenlun mountains, than by the local climate, it has ever been the terror of the countless millions through whose midst it flows.

From the earliest times an immense force has been at work to keep it from breaking through its dykes, or, when this has happened, to guide and retain it between new embankments. The quantity of solid material carried by the river and deposited along its course, is so great that its bed is rapidly raised, and appears to have been, before the last change, higher than the adjacent country.

Biot says, "it is certain that the bed of the river, from Hwaiking to the sea, is higher than the adjoining country."

Several times, during the great wars that have preceded the downfall of dynasties, this condition of the river has been turned to account as a weapon of offense. Breaking the embankments has been made to accomplish, almost instantaneously, by the destruction of hundreds of thousands of inhabitants, conquests that had been delayed by years of brave resistance.

From the earliest time of colonization on the delta-plain, the task of keeping the Hwang Ho within its bed has been the constant care of the rulers of China, both when the country was united under one man, and when it has been subdivided nto petty states. In the latter case in the treaties bordering n the Hwang Ho, the clauses regarding the regulation of that iver appear to have been the most important and the most acredly observed.

One of the most striking results of the official corruption hat becomes general during the decay of a dynasty, is the breaking loose of this great stream as soon as the means for maintaining its embankments are misapplied.

The devastation caused by these overflows is awful beyond description. The loss of life is very great, and the destruction of the crops that form the means of support of millions, produces famine and the overrunning, by starving hordes, of the more fortunate districts of the adjacent country. The anarchy that rules in this struggle for life is almost beyond the conception of those who inhabit lands where the population is much below the capacity of the country, or which are easily reached by foreign supplies.

Within the last fifteen years one of these great changes has taken place, apparently from the same cause and with the same effect as above indicated. Instead of emptying into the Hwang Hai, or Yellow Sea, the Hwang Ho now has its mouth in the gulf of Pechele, which it enters through the Tatsing river. The old mouth of the river was found to be dry in 1858.

According to information furnished to the Rev. Mr. Edkins, by officials of the Board of Foreign Affairs at Peking, the principal break occurred at Fungpeh (ting) in Süchau (fu), the waters flowing away to the N.E. In Tsinan (fu), the capital of Shantung, the waters of the Tatsing river are increased to six times their original volume by the contributions of the Hwang Ho.

In 1863 the river had not yet determined a channel, but its waters were spread over large tracts of country, and the city of Wuting (fu), nearly sixty miles north of Tsinan (fu), was almost inaccessible.

The present course of the Hwang Ho is indicated, so far as known, on Map No. 10.

Owing to the great quantity of material brought down by this river, and to the absence of great oceanic currents, that might, if present, interfere with its deposition, the delta is rapidly increasing in size, and the adjoining seas are becoming shallower.*

Probably nowhere can the rate of growth of deltas be better studied than in China. Cities that were built on the delta plain of the Hwang Ho several thousand years since are still in existence, together with the archives of their history. In the cases of those that were built near the sea, the distances from this are given; and frequent mention is made of towns, mounds, and natural hills, washed by the sea, within historical times, which are now far inland.

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* *Barrow estimated the hourly discharge of sediment at 2,000,000 cubic feet.*

Thus, in B. C. 220, the town Putai is said to have been one li west of the sea-shore, while in A. D. 1730 it was 140 li inland,[*] a yearly increase of 100 feet, more or less, according to the length of the li. Hienshuikau (on the Pei Ho, in long. 117° 32′ E.) is said to have been on the sea-shore in A. D. 500,[†] and is at present about eighteen miles distant, an increase of about 81 feet per annum.

Along the southern shore of the gulf of Pechele the yearly increase N. E. of Shukwang since B. C. 220, seems to have been not more than 30 feet.

The sea-shore, according to local tradition, was near the present location of Tientsin (fu) during the Han dynasty.

It is also recorded that under the reign of the Han, the Hwang Ho entered the sea at Changwu, near the present Tsinghai.[‡]

Art. XXVI.—*Test for Bromids;* by Surgeon J. H. Bill, U. S. Army.

In conducting some investigations during the past summer, on the physiological relations of the halogens, it became absolutely necessary in the course of the experiments, to devise a ready and sensitive test for bromine in the presence more particularly of chlorine.

Any analyst will bear out the assertion—although the books make light of the matter—that it is a difficult thing to recognize traces of bromine in the presence of excess of the other halogens. Thus in the case stated above, it was found impossible to obtain by the ordinary methods of the books, a certain, and easy recognition of bromine, when chlorine was present.

The Fresenius test solution of auric chlorid produces in faintly acid solutions of alkaline bromids, a coloration ranging from dark orange red, to light straw color, according to the strength of the solution. Iodids must be out of the way. Chlorids, however, do not interfere in the least. The following is the best way of applying the test. Separate iodids by palladium, and after getting rid of excess of palladium, by sulphuretted hydrogen, concentrate the solution to about twenty-five cubic centimeters. Select two test tubes of the same size and shape, and color of glass. Into one pour the solution suspected to contain bromid. Into the other pour pure water, adding perhaps a trace of chlorid potassium; add now to each test tube, a drop of chlorhydric acid, and then to each *one* drop of auric chlorid solution. On now comparing the two tubes particularly in the direction of their long axes, a yellow color will be observed in the tube containing the bromid, and made very manifest by comparison with the other tube.

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[*] *Fangyuchiyau*; Chihli. [†] Fangyuchiyau; Chihli. [‡] Ibid.

The following experiment shows the delicacy of the test applied as above. One centigram of potassic bromid was dissolved in one thousand cubic centimeters of water. Thirty centimeters of this solution, compared with thirty centimeters of a very weak solution of potassic chlorid, gave a decided yellow color. This experiment was varied by dissolving a gram of potassic chlorid in two thousand cubic centimeters of water, halving, and adding one centigram of potassic bromid to the one half. Thirty centimeters of each of the two solutions now tested, gave ample evidence of the presence of bromid.

The mixed chlorid and bromid should be brought to the state of salts of the alkalis if necessary, by precipitating with argentic nitrate, thoroughly washing, and fusing with potassic carbonate. If sodic carbonate is used, the subsequent reaction with the gold test is not so decided.

A test for chlorid in the presence of bromid, as simple and delicate as the above, is much needed. The writer has sought long for it but in vain.

1607 N. 6th St., Philadelphia, Pa.

ART. XXVII.—*Shooting Stars of November 14th,* 1867.

IN addition to the observations upon the November meteors of 1867, given in the last No. of the Journal (pp. 78–92), the following have been received.

1. *At Dartmouth College* (lat. 43° 42′ 15″·2, long. E. 19^m 03^s), by Prof. C. A. YOUNG.—The observations were made by myself, assisted by a corps of volunteers from the Junior Class and the Chandler Scientific School.

Four observers were kept in position facing the cardinal points, and relieved at intervals of about twenty minutes, as the weather was very cold (thermometer ranging from 14°·0 to 20°·0 F.), with strong N.W. wind, and three or four inches of snow on the ground.

These four observers kept a record of the number of meteors appearing in their respective quarters of the heavens, while my own attention was mainly directed to plotting upon one of Mr. Hoek's star-charts the paths of such as were determined with sufficient accuracy, and noting with a chronometer the instants of their disappearance.

Observations commenced at midnight, at which time the sky was covered with swiftly drifting clouds; the wind gradually died away, and at 3ʰ 45ᵐ the clouds disappeared, leaving a perfectly clear sky.

Before 3 o'clock the number of the meteors was disappointingly small, partly on account of the clouds. About 3 o'clock they became more common, by 4ʰ they were numerous, and at 4ʰ 45ᵐ (local time) when the display reached its maximum, they were countless, appearing in squads, sometimes as many as a dozen at once. After 4ʰ 40ᵐ no regular count was kept by the four observers, but at intervals of 15 minutes I noted the time required to count a number, looking toward the constellation Leo, but including in my count all that I could see with my head in that position. The annexed table contains the results.

	No. observed.								
Time of Observation.	N.	E.	S.	W.	Total.	No. pr. h'r.	Cloudiness.		
12 to 3 A. M.	34	46	31	7	118	39	0·7	130	4 observers.
3 to 4.	66	70	72	28	236	236	0·5	472	
4 to 4·15.	113	102	81	73	369	1476	0	1476	
4·15 to 4·30.	173	168	136	97	574	2296	0	2296	
4·30 to 4·40.	251	206	185	117	759	4554	0	4554	
Totals,	637	592	505	322	2056				

At 5 o'clock 50 were counted in 2 m. 20 secs.,	1286	1 obs'r.
At 5·15 " 50 " " 3 m. 40 secs.,	818	
At 5:30 " 25 " " 3 m. 50 secs.,	291	
At 5·45 " 10 " " 5 m. 50 secs.,	103	

The last column of the table contains the number per hour, after allowing for cloudiness. The last four numbers in the column would require to be rather more than doubled to bring them up to the standard of four observers.

I do not think the number seen at this place can reasonably be estimated lower than 5000, and that too in spite of moonlight so strong that, aided as it was by the reflection from the snow, one could easily read or write by it.

The radiant, as determined by a rough graphical reduction of the paths of 82 which were mapped, appeared to be about 1° 30′ in diameter, with its center in Dec. +22° 15′ and A.R. 10ʰ 02ᵐ. A motion of this point from south to north was suspected, amounting to about 1° or 1° 30′ in the 4 hours from 1 to 5. The observations, however, will need a more thorough reduction in order to settle this question.

Most of the meteors were small, perhaps one in ten being equal to a first magnitude star. At the time of maximum the large ones were in still smaller proportion. The finest one seen here appeared at 1^h 57^m just N.E. of the radiant. It was considerably brighter than Venus, and left behind it a train of brilliant greenish light (very much like burning brass), about 6° in length, which endured *more than six minutes.* This train gradually changed its form, doubled up, and floated away like a little cloud toward the N.W., evidently carried by some atmospheric current in the upper air. Before 8 A. M. the surface current had changed to the same direction. During the last two minutes of its visibility it was impossible to distinguish whether the train was seen by its own phosphorescence, or merely like any other cloud, by reflected moonlight. The train of one other meteor endured 90 seconds, and five others from 30 seconds to a minute.

The trains of the conformable meteors, without exception I believe, all shone with *greenish* light.

An unconformable meteor which appeared at 5^h 15^m formed a beautiful contrast to the others; it moved from Orion toward Canis Minor, very like Mars at its nearest oppositions in brilliancy and color, and left a train of the same hue. Its apparent velocity was only about half that of the conformable meteors.

As a general rule the meteors disappeared simply by burning out, without any appearance of explosion; to this there were three or four exceptions, but no noise was ever heard.

The time of flight varied from 0^s·1 to 0^s·7, except in the case of the unconformable meteors, which moved more slowly. About a dozen of these were noted during the night.

2. *At Iowa City* (lat. 41° 40′, lon. W. 14° 40′), by Pres. N. R. LEONARD.—A company of the students of the State University had been formed some three weeks previous to the 14th of November, for the purpose of watching for the meteor shower, and making observations upon it if it made its appearance.

The lookout was commenced on the morning of Saturday, Nov. 9, and continued each clear night till the evening of Nov. 13th, four persons keeping watch at a time, or one for each cardinal point of the compass. With the exception of the mornings of Nov. 9th, and Nov. 12th, no more meteors were visible than may be seen on any ordinary night.

On the evening of the 13th, the prospect for a clear sky was very poor. A sort of haze seemed to prevail and light clouds spread over the heavens; these dispersed slowly until *toward midnight all had* disappeared. The moon, then but little past its full, arose before the hour for commencing operations, and under its light all stars below the third degree paled away and became invisible. I noticed the Pleiades then just beyond a lunar-halo, but so feeble was their light, that only by looking steadily in the direction in which they were known to be, could they be perceived. I do not believe that a meteor of the average brightness of the Pleiades would have been perceived.

The company of observers was divided into three sections of twelve each, to watch respectively, from 10 o'clock to 12, from 12 to 2, and from 2 to 4 o'clock. The position chosen for an observatory, was an octagonal room in the cupola of the University. In each side of this room there is a window having an exterior column on either side, so that when the sash and shutters were removed, eight observers, stationed one at each of these windows, would command the entire circuit without any considerable overlapping of their fields of view.

One person was stationed at each of these positions, and two others were placed in a reclining posture on platforms outside, to watch for any meteoric flights that might occur near the zenith. One man stood at a desk within to make a record of the observations, while the twelfth was to act as occasion might require.

The paper for the recorder was ruled thus:

Quarter of compass.	Direction of motion.	Conformity.	Time visible.	Arc of motion.	Remarks.

The following is the record of the numbers counted, and of their conformity or non-conformity in direction to a line proceeding from the constellation Leo :

Hour.	Conformable.	Unconformable.	Total.
10 to 11	2	5	7
11 to 12	6	7	12
12 to 1	35	16	51
1 to 2	102	17	119
2 to 4	Nearly all conformable,		5,000

During the last two hours the number actually counted was 4,748, but through mistake on the part of the person stationed at the west window, he only continued to call out to the recorder the direction, &c., of the brightest, without keeping in his own mind the total number of those seen. The division of the time between 2 and 4 o'clock was not noticed, so that the last two hours have to be given together.

In regard to their conformability, as soon as Leo had attained an altitude sufficient to admit of careful observation, it was found that nearly all the meteors seemed either to issue forth from a point marked on our globe by the star 97, near the center of the sickle in Leo, or that, if their courses should be traced back, they would intersect at that point. For a few minutes, about $3^h 15^m$ A. M., we carefully noticed those appearing in this quarter of the heavens, and they seemed to indicate a radiant *point* at the star mentioned; at about 3½ o'clock it seemed that the radiant was a *line*, or, at most, a *very narrow ellipse*, having its center at this star, and extending in the direction of the star *zeta* in the sickle.

The exact number of conformable meteors for the last two hours cannot be given. Out of 1,638 counted by three observers having their attention directed to this subject, only 22 were noted as unconformable.

At 20 minutes before 1 o'clock, it was found that one person could not record fast enough, and the unemployed man undertook the record for one half of the circuit.

At quarter past two, both recorders were unable to keep a full record and from this time forward each observer counted to himself the number appearing in his quarter, and only called out the most remarkable for record. Some time before 3 o'clock a second observer took his place at the S.E., and soon after a second upon the east. The result of their counting will be seen in the Quarter Table.

QUARTER TABLE.

Hour.	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Total.
10–11	0	2	3	2	0	0	0	0	7
11–12	1	1	1	3	0	5	1	0	12
12–1	8	15	5	5	4	10	3	6	56
1–2	25	35	20	16	3	6	4	6	115
2–3				150		No count.			
3–4	693	635	721	1100	507	336	158	448	4748
Total,	727	687	750	1276	514	357	166	560	4937

The maximum of the display as to numbers was from $3^h 15^m$ to about $3^h 40^m$ A. M. During this period, other parties of nine each were formed and counted the stars issuing from the constellation Leo, finding on the average about 40 per minute. After $3^h 45^m$, the diminution was rapid, as may be seen by this comparison. The number counted in five minutes being—from $3^h 21^m$ to $3^h 26^m$, 222; from $3^h 41^m$ to $3^h 46^m$, 135; from $3^h 50^m$ to $3^h 55^m$, 106; from $3^h 56^m$ to $4^h 01^m$, 72; and from $4^h 03^m$ to $4^h 08^m$, 50.

Those stationed on the southeast quarter, counted by hundreds from 3 to 4 o'clock, with the following result: Time of *first 100 was 7 minutes;* of the second, 5 minutes; the third, 6 minutes ; fourth, 3 minutes ; fifth, 3 minutes ; sixth, 3 minutes; seventh, 2 minutes ; eighth, 2 minutes ; ninth, 2½ minutes ; tenth, 4 minutes ; eleventh, 10 minutes—closing the count at 3^h 55^m A. M. It will be found by adding these times that they lost 7½ minutes. Most of this loss occurred after the eighth hundred, at 3^h 31^m, when they were unable to count reliably because of the great number that appeared, so that their maximum would be about 3 hours and 35 minutes by their time, which was 7½ minutes too fast.

Of the 1,100, they considered that only 5 were unconformable.

Color of the trains.—Record was kept of 155 of the most luminous trains, with this result:

Green,	49	Very green,	9	Total,	58
Red,	35	Very red,	14	"	49
White,	24			"	24
Train and meteor of different color,					24
					155

As to the green there was some disagreement—some calling that blue, which others pronounced to be green.

In regard to the color, it is my impression that the proportion given by the above figures is not true, save for the brightest meteors—for of the hundreds that left trains behind them the greater number seemed to be of a green color—very many yellow at the middle and gradually changing to green at the margin—a color a little darker than the flame of the metal barium, and not far from the hue of copperas. On comparing this statement with the views of several observers, I find all agreeing thereto.

There were several particular observations taken. The first to be mentioned is, that in some instances a separation took place between the meteor and its train, before the former disappeared.

At 9 minutes to 3, a meteor started from the radiant and proceeded directly over the star *Dubhe*, (the northernmost of the two pointers), followed by a broad train about 5 degrees long. The separation of the meteor and train took place just as the former crossed the star named. The train remained visible for the space of 4 minutes, drifting meanwhile to the S.E., shortening up as it went, without, however, growing much, if any, narrower, and disappeared after retreating about 7 degrees. The last glimpses that I had of it gave me the idea of a spiral form, but I could not be very positive about it.

At 4 minutes to 3, another meteor left the radiant and proceeded to the star *Zeta Draconis*, leaving there a train, behavng just as the last described, retreating 2 degrees in 3 minutes. At 3 minutes after 3, another passed over *Mizar*, (the middle tar in the handle of the Dipper), leaving there a train that etreated 1½ degrees in 2 minutes.

At 8 minutes after 3, a very large meteor passed over to the head of Orion, leaving there a train 11 degrees long, and almost immediately afterward was seen to separate into several parts and disappear. The train floated a little to the east of south, a distance of 11 degrees, the middle moving more rapidly than the extremities, so that it took up the form of a crescent, with the horns pointing N.W. It should be noted that this train appeared near to the full moon, so that its period of visibility was thereby much shortened. From this train before the separation, one observer thought he saw three small black streaks descending for a short distance, and curved backward toward the bottom.

At 1 minute after 4, another meteor passed over to Sirius, leaving midway from Leo a train that exhibited the same movements as the last, giving the crescent shape before disappearance.

A change of course in the path of a meteor was carefully noted in one instance. A little after 3½ o'clock, a deep red meteor was seen passing very rapidly through Leo Minor, toward the N.W., describing an arc of 15 degrees, in ¼ of a second. About midway of its course it turned abruptly toward the west, at an angle of 15 or 20 degrees, with its previous direction.

Several bright meteors were seen to *flash out*, remain stationary, or nearly so, for an instant and then disappear. As a rule, it may be stated that the nearer these were to the radiant point, the less was their motion.

From a careful examination of the records made, there appeared to be difference in the *length* of the arc of flight, which has some connection with the quarter in which the meteor was seen. The following exhibits the average length for the last two hours:

Length of arc by quarters.

Hour.	N.	N. E.	E.	S. E.	S.	S. W.	W.	N. W.					
2–3,	16°	13°	6°	14°	28°	20°	17°	15°	Found	from	107	obs'd	arcs.
3–4,	18°		11°	12°	23°	15°	16°	20°	"	"	125	"	"
Average for night,	17	19	10	14	20	17	19	18	"	"	350	"	"

The arcs described in the N.E., E. and S.E., are thus seen to be shorter than the average, but their *time of visibility* was a trifle *greater* than for other quarters.

In noticing the *rate* of motion, a difference will be found with respect both to the *hours*, and the points of the compass. Thus, by hours:

10—11,...16° per sec.
11—12,...15° "
12—1,...19° per sec.
1—2,...28° "
2—3,..21° per sec.
3—4,..19° "

By quarters of compass.

N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
20°	18°	20°	17°	25°	20°	21°	20°

Very few were timed during the last two hours, in the first four of the above quarters. From the few, we shall derive a series of numbers much smaller than the above. In the last four a considerable number were timed and the resulting velocity arcs are greater, thus:

N.	N.E.	E.	S.E.	S.	S.W	W.	N.W.
12°	10°		17°	30°	22°	21°	23°

I will conclude this article with a table showing the direction of the flights of the meteors, arranged according to the quarters whence they issued.

Direction of flights commencing at 12 o'clock, 1 denoting 1st hour, 2 the 2nd hour, &c.

DIRECTION TABLE.

Origin of Meteor.		Direction of motion.							
		N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
N.	1	1	1	--	--	--	3	--	1
	2	1	1	--	--	--	--	4	9
	3	2	--	--	--	--	--	13	1
	4	--	--	--	--	--	--	3	2
N.E.	1	--	4	--	--	--	1	5	2
	2	9	6	--	--	--	--	2	6
	3	3	3	--	--	--	2	--	1
	4	--	--	--	--	--	--	1	--
E.	1	--	1	--	2	--	8	1	--
	2	--	1	2	6	2	--	1	--
	3	1	9	5	4	--	--	1	1
	4	2	9	6	3	--	--	.	3
S.E.	1	--	--	--	--	2	2	1	--
	2	1	--	--	4	4	3	2	--
	3	--	--	1	--	5	12	--	--
	4	--	--	--	1	1	1	--	--
S.	1	--	--	--	--	--	3	--	--
	2	--	--	--	--	--	1	--	--
	3	--	--	--	1	--	15	1	--
	4	--	--	--	--	2	27	--	--
S.W.	1	--	--	--	--	1	--	6	2
	2	--	--	--	--	--	2	3	--
	3	--	--	--	--	--	6	3	--
	4	--	--	--	--	--	3	17	--
W.	1	--	--	--	--	--	1	1	--
	2	--	--	--	--	--	2	1	--
	3	1	--	--	--	--	2	9	--
	4	--	--	--	--	1	--	9	--
N.W.	1	--	--	--	--	--	1	1	2
	2	--	--	--	--	--	1	--	3
	3	--	--	--	--	--	5	4	6
	4	1	--	--	--	--	--	29	16

Totals for these columns:	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
	23	35	14	21	18	96	114	55

But few were described as to direction during the last hour, at the first four stations. However, enough is presented to show three things.

1st. That the greatest uniformity as to direction is to be found in those quarters farthest removed from the radiant.

2d. If the breadth of this table be increased two fold—and the sheet wrapped on a cylinder, the line of maximum direction will run around it from top to bottom, like the coil of a helix.

3d. The prevailing direction of motion is toward the west, or a little south of west.

3. *Observations at the U. S. Naval Observatory, Washington, D. C., and at Richmond, Va.*—From the published reports[*] of Prof. Newcomb, Prof. Eastman, and Prof. Harkness, to Commodore Sands, we give a few extracts.

Two sets of observations were arranged, one in coöperation with northern observers, and one in conjunction with Prof. Harkness who went to Richmond for the purpose of making observations for parallax. The first set was assigned to Messrs. Zumbrock, Titman, Lindenkohl and Main, of the Coast Survey, who assisted on the night of the 13th–14th. Prof. Newcomb observes that the trains were green upon their appearance, but changed to red and brown in a fraction of a second. He locates the radiant a portion of a degree north of that point of the line joining γ and ε Leonis which is one-third of the way from γ to ε.

He gives the following method of computing the heights of the meteors observed at Washington and Richmond.

"Out of 21 of the more brilliant meteors recorded by Prof. Harkness at Richmond, it appeared, from the identity of times, that 11 had also been observed at Washington. Of these 11, one was far south of Richmond, so that no reliable parallax could be obtained; and another seemed to be a mere accidental coincidence in time of two meteors, as they were seen in entirely different directions. The mode of obtaining the heights and distances is as follows:

"Mark on the celestial globe the path of the meteor as seen from each station, and continue the paths backward as great circles until they intersect. The point of intersection will be the radiant for that particular meteor. Take a plane perpendicular to the direction of the radiant as a fundamental plane. It will then be necessary to find the projections of the observing stations on this plane, which we shall represent by S and S_2, and also the positions, relatively to those projections, of the point in which the meteor path would, if produced, cut the fundamental plane, which we shall call P. To do this set the celestial globe so that the radiant shall be in the zenith. Then the horizon will represent the great circle in which the fundamental plane cuts the celestial sphere, which may be marked on the globe. The two meteor paths being now continued to the horizon, the azimuths of the points in which they meet the horizon will be the azimuths of the point P as seen from the points S and S_2 respectively. Call them A and A_2. Next, we want the azimuth of the line SS_2. To determine this, the terrestrial azimuth and depression of one station, as seen from the other, must be computed. Then rectify the globe for the latter station and for the moment of observation, and mark upon it the position of the other station as seen from it. From this point let fall a perpendicular Q upon the fundamental great circle. The azimuth of the point of meeting, measured upon the fundamental great circle, will be the azimuth of the line SS_2, which we shall call Z, and the distance SS_2 will be equal to the distance of the stations multiplied by the cosine of the perpendicular Q. Thus, in the triangle SS_2P, we have found the side SS_2 and the adjacent angles A—Z and $180°+Z—A_2$. The sides SP, and S_2P are then found by the solution of this triangle. The observing stations being projected on S and S_2 by lines parallel to the course of the meteor, it follows that *the sides* S*P and* S_2P, *are equal to the perpendicular let fall from the observing stations upon the straight line in which the meteor moves.*

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[*] *Observations and discussions of the November meteors of* 1867. U. S. Naval Observatory, Washington. Government Printing office, 1867. 8vo, 40 pp. and 3 maps.

"Let Δ and Δ^1 be the angular distances of the meteor from the radiant at commencement and extinction, as seen from the first station, and Δ_2 and Δ^1_2 the corresponding distances as seen from the other station. Then the meteor and the points P and S will form a triangle right-angled at P, the angle at the meteor being Δ at first appearance and Δ^1 at extinction.

Hence, we have—

$D=PS \text{ cosec.} \Delta$ = distance of meteor from first station at commencement.

$D^1=PS \text{ cosec.} \Delta^1$ = distance of meteor from first station at extinction.

$D_2=PS_2 \text{cosec.} \Delta_2$ = distance of meteor from second station at commencement.

$D^1_2=PS_2 \text{cosec.} \Delta^1_2$ = distance of meteor from second station at extinction.

"Finally, the heights of the meteor above the earth will be found by multiplying these distances by the sines of the observed altitudes, correcting them, if necessary, for the effect of the rotundity of the earth. It will be seen that a separate value of the heights is obtained from the observations at each station. This is because more data are given by the observations than are necessary for the solution of the problem, and the solution is therefore so arranged as to give two values of each of the unknown quantities. The agreement of these values will furnish a rough check on the accuracy of the observations.

"The actual length of the path described by the meteor, as given by the respective observers will be—

$$PS\ (\cot.\Delta - \cot.\Delta^1)$$

$$\text{and } PS_2\ (\cot.\Delta_2 - \cot.\Delta^1_2)$$

"If the observations agree, we have also—

$$PS\ \cos.\Delta = PS\ \cos.\ \Delta_2 + SS_2\ \tan.Q.$$

$$PS\ \cos.\Delta^1_2 = PS_2\ \cos.\Delta^1_2 + SS_2\ \tan.Q.$$

"From the fact that the errors of observation in the direction of the meteor track are, probably, many times greater than those in the perpendicular direction, it follows that this method of determining the heights and distances will be much more accurate than that in which no account is taken of the, direction of motion.

"The present observations were discussed in the above way with a single modification. The precision with which the meteors appeared to radiate from the point in right ascension 151° and declination 22½° was such, that any deviation of the recorded tracts from a great circle passing through this point was presumed to be due to errors of observation. The most probable point of the track was supposed to be about two-thirds of the way from the beginning to the end, and the azimuths A are the azimuths of those points as seen from the general radiant."

In this way he obtained the following heights (in miles of 5280 feet) for 9 meteors.

No.	Height at beginning.	Weight.	Height at ending.	Weight.
2	72 miles.	7	30 miles.	12
3	108 "	5	55 "	9
5	74 "	6	47 "	9
6	82 "	5	38 "	9
7	90 "	6	50 "	10
8	104 "	4	41 "	8
9	115 "	5	58 "	9
10	79 "	7	41 "	11
11	198 "	2	65 "	5
	Mean, 102 "		47 "	

Prof. Newcomb adds, "It appears from the observations that the mean height of the meteors, at first appearance, was 102 miles, and at disappearance 47 miles. The motion being oblique at an angle of 35° from the perpendicular, the actual mean length of the path of the meteors would appear to be 67 miles. But this length must be too great, since the meteors certainly went through their course in one second or less, probably in half a second. Their velocity being 44 miles per second; the mean length of path can hardly exceed 22 miles. This very great discrepancy is accounted for by the tendency of the eye to assign to a swiftly darting body, which suddenly appears and disappears, a range of motion much wider than its actual range, and especially to place its point of beginning too far back. Allowing for this I conceive that, on the average, *the brighter meteors first appeared at an average height of 75 miles, and were extinguished at an average height of 55 miles above the earth.* I would also remark that there is no positive evidence that any one meteor commenced at a greater height than 100 miles.

"I would also beg leave to submit some deduction respecting the probable number, magnitude, and nature of the meteoroids.

"During the thickest of the shower, meteors were counted at the rate of 3,000 per hour. In making this count it may be estimated that the observers saw all that fell within a circle of 150 miles in diameter, having its center 75 miles S.E. of Washington. From this number and the velocity of 44 miles per second, it would seem that in the thickest part of the stream traversed by the earth on November 13th, there was an *average of one meteoroid in 900,000 cubic miles of space.* In other parts of the stream they may, of course, be much thicker.

"Supposing three hours to be the usual time of a November shower, the thickness of the stream from north to south would appear to be 60,000 miles. The breadth is probably ten times as great, so that its transverse area may be estimated at 36,000,000,000 of square miles. The meteoroids are, therefore, distributed along it at the rate of 40,000 to the linear mile. The stream moving at the rate of 27 miles per second, it may be estimated that a million of meteoroids pass in a second. Since it takes the stream years to pass, we may roughly estimate that the total number of meteoroids in it may amount to a hundred million of millions. This is a mere rough estimate, which may be ten times too large or too small, the data being altogether insufficient for anything like accurate computation. But the data for estimating the magnitude of the particles are far more slender. Several of the meteors were so brilliant that Mr. Doolittle could see their reflection from the face of his chronometer in a bright moonlight, though their distance was from 100 to 200 miles. I myself compared the more brilliant ones to a Roman candle, seen at the distance of 200 or 300 yards. To throw so great a light to the distance of 150 miles *would require several thousand millions of common candles.* Giving so intense a light, it might seem that the body from which it emanates must be very large. But from the dynamical theory f heat, and from the experiments of Prof. William Thompson nd others on the increase of temperature experienced by a ody moving through the air,* it appears that such a body is xposed to an increase of temperature represented in degrees f Fahrenheit by $\frac{v^2}{125^2}$, where v is the velocity of the body in feet per second. Hence, a meteoroid moving through the air with a velocity of 230,000 feet per second will be exposed to a temperature of more than 3,000,000° Fahrenheit, a temperature of which we see the effect in the intense brilliancy and almost instant vaporization of the body exposed to it. Assuming a mean weight of one grain, the entire mass of the stream may be rudely estimated as equal to that of a mass of iron 400 hundred feet in diameter.

"It is now known that the entire stream of November meteoroids follows Comet I of 1866, commonly called Tempel's comet,† in its orbit. Through the telescope this comet presents the appearance of a mass of vapor. Bodies possessing this appearance on the earth, such as steam, smoke, and clouds, are known to be composed of minute detached particles of dense matter. And no other known form of matter can present it, except an elastic gas. The comet in question cannot consist of an elastic gas, because there is no central nucleus of sufficient magnitude to prevent its instant expansion through space. From these considerations, I deem it probable *that Comet* I, 1866, *is simply an agglomeration of meteoroids, just dense enough to be visible in the solar rays.* And since other telescopic comets present the same appearance, it is probable that telescopic comets in general are formed of such agglomerations."

Prof. Harkness from 21 paths observed at Richmond, obtained for the place of the radiant R. A. 149°, Dec. +24°.

The determination of the mass of the meteors is still a dissideratum. Prof. Harkness gives an elaborate discussion of this subject, assuming that the light produced is always proportional to the amount of material consumed. This assumption is necessary, though known to be not strictly correct. It is admitted only because science has hitherto failed to furnish any better mode of estimating the mass of meteors.

The results of the computation are embodied in the following table, in which the columns, A, B, and C, are obtained severally by using constants derived from the burning of coal-gas in fish-tail burners, from the Drummond light, and from the electric light.

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* Philosophical Transactions for 1860.

† *This comet was also independently* discovered by Paymaster H. P. Tuttle, *U. S. N., at this observatory,* on the 5th of January, 1866.

Light of Meteor.	Mass of Meteor, in grains. A.	 B.	 B.
10 Jupiter	2533·	108·6	8·114
Jupiter	253·3	10·86	0·811
Sirius	162·0	6·99	·522
1st mag. star	21·6	0·929	·069
2d mag. star	7·43	·318	·024
3d mag. star	3·71	·159	·012
4th mag. star	2·21	·095	·007
5th mag. star	1·46	0·063	0·005

"It is almost certain that the masses given in column C are too small, because, in order to obtain them, it would be necessary that the whole mechanical force of the meteor should be converted into light, without any obscure heat whatever. Under the circumstances such a result seems impossible. On the other hand, the masses given in column A are probably too large, because meteors burn at an immensely higher temperature than coal gas. The temperature at which the Drummond light is produced is among the highest attainable on the surface of the earth by any known process, and it probably approaches more nearly to that of the meteors than any other artificial means of illumination. For that reason, I think we may fairly adopt the numbers given in column B as tolerable approximations to the actual masses of these meteors.

"It will not escape notice that all the larger meteors leave trains behind them, and as the light of these trains is not taken account of in the formula given above, the masses, just found, should in strictness, be slightly increased ; but the uncertainty in estimating the brightness is so great that the small error thus introduced is scarcely worthy of mention. Finally, notwithstanding all the uncertainty to which the method here employed is liable, yet it would seem that we may reasonably conclude *that the mass of ordinary shooting stars does not differ greatly from one grain.*"*

Prof. Eastman locates the radiant (by means of recorded paths), at R. A. 148½°, Dec.+22½°.

Up to 16^h 37^m, one thousand meteors were counted, four observers being engaged a part of the time, and two the other part. From this time successive hundreds were counted by four persons in the following intervals; viz., 4^m, 5^m 30^s, 5^m 35^s, 5^m 45^s, 9^m 2^s, 9^m 37^s, 10^m 31^s, and 18^m 20^s.

According to Prof. Eastman's observations, "the prevailing color of the trains was green, varied occasionally by orange and red. In several instances the middle of the train was green, and the edges were tinged a deep orange or red. Many of the trains remained visible several seconds, and sometimes even minutes after the disappearance of the meteor. The train of No. 52 was very brilliant, and visible about five minutes. It appeared to float toward the north as if driven by a steady breeze."

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* *The cloud left behind by the larger meteors fills several cubic miles of space. The mass of the meteor must be sufficient to create such a cloud.* H. A. N.

ART. XXVIII.—*On the occurrence of living forms in the hot waters of California*; by ARTHUR MEAD EDWARDS. (In a letter to the Editors, dated 49 Jane st., N. Y., Jan. 23, 1868.)

IN the May (1866) number of the Journal, were some notes by Prof. Brewer on the occurrence of living forms in the hot and saline waters of California, in which a slight error appeared, tending to mislead naturalists more particularly with regard to certain observations of mine. In the subsequent number for November, Prof. Brewer inserted a note making a correction in this matter, but, as the subject is one of much importance, I have taken the liberty of putting together a few notes relating thereto, and beg of you to insert them, at your convenience.

The facts in the case of the Californian water are as follows: Prof. Brewer was under the impression that I had found animal as well as vegetable organisms in several specimens collected by him during the prosecution of the State Geological Survey, and so wrote. I received but one specimen from hot or saline water, and that was gathered at the Geysers in water of a temperature of 120½° F. Unfortunately the rest of the collections made at this and similar localities did not come into my hands, but I have arranged so that I shall before long have specimens of this description, and doubtless the examination of them will throw much light upon the subject under consideration. Of the material I did receive, the amount was very small, and I made, as I had been requested, a very careful examination, with these results. I found it to consist mostly of fine sand, mixed with a little of what seemed to be the refuse of decaying vegetation, which we might easily understand would be blown or otherwise carried into the Geyser. Besides these substances, I found it to contain a very few frustules of Diatomaceæ; true aquatic plants. They are an *Orthosira*, most likely *O. crenulata* of Kützing which is the same as *Gaillionella crenulata* Ehr., and has been placed under *Orthosira orichalcea* W. S., and by Smith in his Synopsis. The number of frustules of this species is small, but enough for its determination. Besides this, I found perhaps half a dozen frustules of a *Fragillaria*, most likely *F. capucina* Desm., which is synonymous with *F. rhabdosoma* Ehr. I also saw a fragment of a much larger species which looked as if it were *Cocconema lanceolatum* Ehr., but, as the piece was very small, I cannot be certain. There are also present some hollow hairs or spines which might have belonged to aquatic crustaceans, but are of a dark brown color, and therefore I am of opinion were derived from some insect and of extraneous origin. It will thus be seen that what I found in the single specimen I examined hardly bears out Prof. Brewer's remarks on the occurrence of living organisms in these hot waters. The only organized matters I detected were the siliceous loricæ of Diatomaceæ, which we have no proof were living in the water of the Geyser, and might, on account of their extreme minuteness, be carried from a distance, and the hollow spines or hairs which I am convinced are of insect origin. In connection with this matter and bearing upon it in a very close manner, it will be as well to mention here, and thus place upon record, one or two facts to which it may be desirable to refer at some future time. In the number for January, 1867, vol. iii, of Max Schultze's "Archiv für Mikroskopische Anatomie" is a paper by Ferdinand Colm of Breslau, entitled "Researches on the Physiology of the Phycochromaceæ Florideæ." Therein, besides mentioning many facts of interest to students of vegetable physiology, he states that certain *Oscillariæ*, namely, the *Beggiatoa* (one of which, *B. mirabilis*, bends and twists itself in a very remarkable manner, so that it produces vermicular waves and a motion looking like the peristaltic action of the bowels) which live in waters charged with sulphates at a high temperature, and hence, during the process of their growth, decompose the salt present and cause the evolution of free sulphuretted hydrogen. In the abstract of Dr. Colm's paper in the Quarterly Journal of Microscopical Science, the writer remarks that Dr. C. says, "since this group of algæ alone can flourish in hot and strongly saline solutions, it is probable that the first organisms which were present in the primordial sea which covered the earth, and was of very high temperature, if we may reason from the deductions of geologists, were *Oscillariæ* or rather *Chroococcaceæ*." Now in the hot springs of California there have been found *Oscillariæ* probably belonging to this order, besides *Diatomaceæ*. Prof. Whitney says, (Geology of California, vol. i, page 94), "Both the earth and the stream are highly charged with sulphuretted hydrogen and sulphurous acid, and the waters hold in solution a great variety of salts, especially sulphates of iron, lime, and magnesia; these salts as well as crystallized sulphur, are deposited over the rocks in the cañon, giving a peculiar and vivid coloration, which is perhaps the most striking feature of the place." This is also confirmatory of the supposition of the growth of plants of this kind in these springs, and it is easy to understand how the sulphur can be eliminated from the sulphates, or even the oxygen abstracted by the vegetation, during the period of its life, and sulphids deposited. In fact, the dark colored iron sulphid is particularly mentioned by Prof. Whitney as found in abundance at the Geysers. Furthermore, in the number of the London Quarterly Journal of Microscopical Science for July, 1867, is a paper by Dr. Lander Lindsey "On the Protophyta of Iceland," wherein he mentions that in the Geysers of that country grow *Confervæ* and *Diatomaceæ*, of which latter he enumerates seven genera, and says "the abundance of Diatoms in the thermal waters of Central and Southern Europe warrants us in expecting large additions to the Icelandic Diatomaceæ from this source alone." Now it would be of extreme interest to ascertain in what way and to what degree the saline and hot waters affect species of Diatomaceæ, as collections might be made in fresh water if it occurs near the hot springs. Besides, these forms from the saline as well as from the fresh waters of the Pacific coast should be very carefully compared with those found in the immense deposits so common in that part of the world; one of which deposits Frémont found on the Columbia river, and others have been detected by the State Geological Survey of California in that State and elsewhere. The origin of these deposits, and all facts connected with them, are of especial importance at the present time. It must, at the same time, be remembered that the fact as to what constitutes a species in the Diatomaceæ is by no means settled, as less really is known of the life history of these minute organisms than of almost any other plants. Moreover, in the study of the Diatomaceæ and allied families, the observer has presented to him extremely advantageous opportunities of making himself acquainted with many points in the phenomena of cell-life in simple as well as more complex plants and animals. I therefore ask the coöperation of every one at all interested in the prosecution of science and the acquisition of knowledge, to the furtherance of this branch of study; and to such as are able and willing to collect I will furnish plain printed directions, and to all who desire to pursue this branch of investigation I will gladly furnish all the assistance in the shape of information and specimens in my power.

ART. XXIX.—*Topographical and Geological features of the Northwest Coast of America;* by T. A. BLAKE, A.B.

A FEW moments spent in the study of the map of the world reveal the fact that the coasts of the continents, in high latitudes both north and south, which are bordered by high mountain ranges, are peculiarly cut up and present a most intricate, and, if I may use the expression, ragged shore line.

As an instance in the northern hemisphere, we have the coast of Norway, bordered by the Scandinavian range, and in the southern, the eastern coast of Patagonia from the parallel of 40° south, bordered by the Andes.

The northwestern coast of America is no exception to the general rule, but shows, perhaps on a grander scale than in either of the examples cited, the result of the slow but mighty erosive action of glaciers, the formation of which is the natural result of atmospheric humidity, and a low mean annual temperature, due not only to geographical position but to high elevation.

The published and glaringly inaccurate charts of the northwest coast of America, north of the Island of Vancouver, fail to give an adequate idea of the vast archipelago of islands and net-work of channels with which the whole coast of British Columbia, and that of the lower and eastern part, below 59° N. lat., of our new territory Alaska, are fringed.

The straits of Fuca, lat. 48° 20′ (approx.), are the southern limit of this complex system of labyrinthian channels which afford peculiar facilities for inland navigation. They are bordered on the south by the high and snowy range of Olympic mountains in Washington Territory, the peaks of which attain an elevation of eight thousand feet above the sea. The serrated line of summits of this range and the ever varying shades and colors along its bold front, are a source of infinite pleasure to the lovers of natural scenery that may perchance behold them from Victoria on the opposite shore.

The western and northern shores of Vancouver are generally high, culminating in peaks 5,000 feet in elevation, while on the eastern and southeastern border it presents a large extent of gently undulating and productive land.

Victoria, the principal city, is at the head of a small inlet from the straits of Fuca, and although possessing many advantages of climate and location, is now languishing under the effects of the reaction due to its rapid and unhealthy growth during the great Frazer river gold excitement of 1858.

The shores in the neighborhood are rocky, the characteristic rock consists of feldspar and laminated hornblende or pyroxene and is probably eruptive.

The most marked geological feature is the absence of rough surfaces and angular summits. The rocks are everywhere rounded, scooped and grooved. As might be expected, erratic boulders, the material of which is foreign to their present position, are of frequent occurrence, thus giving us another link in the chain of evidence which proves the special agency of glaciers in the peculiar configuration of the coast.

In the outskirts of the city, between it and the hill called Beacon hill, at the head of the small inlet which forms the harbor of Victoria, an ancient sea beach has been exposed by digging a ditch or drain through the alluvial land, the bottom of which I should judge to be at least twenty feet above tide water. The shells which occur there are, according to Mr. Harford, the conchologist of the Alaska expedition, all of existing species. The occurrence of this beach proves a comparatively recent upheaval, subsequent to the extensive denudation and erosion caused by glacial action upon the underlying rocks.

From the slight elevations in the rear of the city, a grand view of Mt. Baker, seventy miles distant, is to be had. This is the last of that line of volcanic peaks in our territory which commences with Mt. Shasta, and stretches northerly through Oregon and Washington Territories.

Its height, according to Mr. Geo. Davidson, Asst. U. S. Coast Survey, and Chief of recent expedition to Alaska, has been accurately determined, by triangulation probably, and is ten thousand eight hundred feet.

The climate of Victoria is mild and equable. A set of meteorological observations taken there during the years 1859, '60 and '61 shows the mean annual temperature to be about 50° Fahr. The coldest weather in 1860, being in January and February, when the thermometer indicated a range of from 47° to 22°, or 10° below freezing, and the warmest in June, the thermometer ranging during that month from 48° to 81.°

I am unable to give the rain and snow fall in inches, but a meteorological record kept by Dr. Chas. Forbes, Surgeon Royal Navy, at Esquimalt near Victoria, shows that during the year 1860, there were 185 fine days, 88 overcast and foggy, 96 rainy, and 4 days upon which snow fell. The rainfall is distributed throughout the year, and greatest in the winter months.

On the eastern shore of Vancouver, the Nanaime coal mines have been opened to a considerable extent and now promise to assume greater importance since the acquisition of the new territory, as the main supplies of coal for steamers going and coming will naturally be drawn from there. From various sources I learn that the beds are much faulted, involving great expense in their exploration, and that they stand at a high angle. The shipments from these mines have been constantly increasing, and have probably reached a total amount of over two hundred thousand tons. The coal is probably of the same geological age as that of the Mt. Diablo mines, and is very similar to it in chemical composition, as shown by the comparative statement of analyses given by our state geologist in his report, (1st vol. geology). The difference, however, is in favor of the Mt. Diablo coal, that containing a smaller percentage of ash, though more water; why the latter is not as well suited for ocean steamers, in the absence of anthracite, as the Nanaimo which is so extensively used, I do not understand.

The shores of Vancouver, and the smaller islands with which the inland waters to the east are studded, are lined with recent deposits, soft and friable, generally horizontally stratified and rarely over fifty feet above the water.

The most important river of British Columbia is the Fraser, which flows into the gulf of Georgia just north of the forty-ninth parallel, or the northern boundary of Washington territory.

The outlying islands afford an admirable barrier against the encroachments of the sea upon its comparatively broad, alluvial valley.

Above this river is a series of long and narrow inlets, often stretching inland for from forty to sixty miles, from one to two miles only in width, and walled with high and abrupt mountains, densely wooded with evergreen trees to an elevation, by estimate, of three thousand feet.

Butte Inlet, at the head of the gulf of Georgia, of which accurate surveys have been made by Capt. Richards, Royal Navy, is bordered by mountains from four to eight thousand feet in height, and there are places in these fiords within one-half mile and less of shore, where no soundings were obtained at three hundred fathoms.

When to such bold features we add the remarkable luxuriance of vegetation which covers these shores, and the innumerable cascades and torrents which leap from the mountain sides, a faint idea may be formed of the majestic and wild beauty of the scenery. It is indeed like sailing through a succession of Yo Semite valleys.

Sitka Island, in our new territory, is a mass of unexplored rugged mountains, many of which are capped with perpetual snow. The town is situated at the head of Sitka bay, the entrance to which is marked by the symmetrical volcanic cone of Edgecombe, which is the second of a series of volcanic peaks bordering the coast and culminating in Mts. Fairweather and St. Elias, the heights of which are variously stated. The latter is in clear weather plainly visible at a distance of one hundred and fifty miles.

The rock in the vicinity of Sitka is a grit, sometimes coarse, often passing into argillite. The trend of this formation seems to be parallel to that of the coast. It extends as far south as the Deep sea, a remarkable fresh-water lake twelve miles southwest of Sitka, on the opposite side of which syenitic granite occurs.

Limestone, highly crystalline, is found within a few miles of the town on the north. The vegetation and general appearance of the coast is very similar to that already described, though the beautiful Sitka spruce which is remarkable for its grace and the mathematical regularity with which its branches grow from the central stem, replaces the Douglass spruce of lower latitudes. Trees grow to large size, many from six to ten feet in diameter being seen.

Of course but little is known of the geology of the country. It is only along the shores that the rocks can be investigated; the roughness of its surface, and thick growth of timber and masses of fallen and decaying trees, covered with deep moss, always saturated with water, almost preclude geological observation. I have yet to learn of a man, white or Indian, crossing from one side of Sitka island to the other, a distance of not over twenty miles in some places.

The meteorological statistics kept for the Russian government show as a mean of twelve years' observations, the mean annual temperature at Sitka to be 42° 9′ (Fahr.), the extremes being very small. The same observations give a mean annual rainfall of eighty-three and three-tenths inches, the maximum being one hundred and five inches.

Along Chatham straits, east of Sitka island, the rocks are metamorphic, stratified mica schists, standing almost vertically, and showing a parallelism in their trend to the line of the coast and of upheaval.

Glaciers are common along the inland waters north and back of Sitka island; these often sweep grandly from the mountain gorges and reach to the water's edge, generally ending in a low crescent-shaped flat formed by the wash from their terminal moraines.

In Icy straits, north of Sitka island, the ice from them falls into the sea, and so great is the accumulation as to render navigation dangerous. In lat. 59° along Chatham straits, every marked depression has its glacier of greater or less extent. These glaciers are to be seen at points as far south as the mouth of the Stachin river, and the lowest known limit on the coast is about 54°, at the head of the narrow inlet on the coast of British Columbia, east of Fort Simpson.

At the head of the peninsula of Alaska is the commencement of another great line of volcanic action which extends to the southwest, forming the peninsula and then, curving to the west, the long chain of Aleutian Islands—"stepping stones," as they have been aptly called, between the two continents—stretching far toward the Kamschatkan peninsula.

The rocks on the island of Kodiak, east of the Alaska peninsula, metamorphic sandstones and shales, also show a general parallelism in their trend to that of this line of upheaval—trending N.E. and S.W. instead of N.W. and S.E. as on the coast of the main land.

During the time spent by the recent expedition at Captain's bay, island of Unalaska, Dr. Kellogg, two of the officers of U. S. R. Cutter Lincoln, and myself made the ascent of Makushiuski Mt., a volcano on the northern end of the island.

A detailed account of the ascent may form the subject of a future article. From our observations the height of the volcano was determined to be, approximately, five thousand six hundred feet, that of the snow line, three thousand one hundred and sixty-eight feet.

No vegetation is to be seen above an elevation of two thousand five hundred feet, except that low form of vegetable life called "red snow" which occurred at an altitude of from four thousand to four thousand five hundred feet. An incipient glacier curves gracefully around through a gorge on the eastern flank of the mountain.

The island is marked by the entire absence of trees, though the hills are covered with a thick growth of grass. Its northeastern end is made up almost wholly of volcanic rocks.

Perhaps the most remarkable view of volcanic cones and peaks, snow covered, and rising from the sea, to be found in the known world, is that of Unimak Island, with its two volcanic peaks of Shishaldin and Pogromnaja, both conical peaks of unbroken symmetry rising to heights of between nine and ten thousand feet above the sea. Between them is Destruction peak, comparatively low and irregular in its outline, showing it to be a volcano in its early stages of development. In 1863 its eruption was the cause of the loss of many lives, whence its name.

The mountains are entirely snow covered and between them are vast intermediate snow-fields; it is only along the shore that the rocks are bare, and that apparently in very limited areas. The angle of side slopes of Shishaldin is about 35°.

Exaggerated ideas have been formed of the *known* mineral wealth of Alaska.

Gold has never, as far as I can learn, been mined with profit within the limits of our new possessions, though it has been obtained in paying quantities on the Stachin river, one hundred and fifty miles from its mouth, in British Columbia.

The coal hitherto discovered is of uniform poor quality, being nothing more than lignite (excepting that found on the Arctic coast), and is of the most recent geological age. The coal on Ounga island is exposed in a bluff rising two hundred feet high from the sea. Our own discoveries may lead to something better.

Magnetic iron ore is reported, but is not known certainly to exist in any large deposits. Lead ore, galena, is also reported to have been found at various places.

Native copper is found on the Copper river, but the hostile character of the Indians in that locality has prevented its exploration.

According to Grewingk, fossils of the Carboniferous age occur at Cape Beaufort on the Arctic coast, of the Jurassic period on the east coast of the peninsula of Alaska, bay of Katmai.

Tertiary fossils occur on the island of Kodiak (Sacharof bay and bay of Igatskoi), at Pavlovsky bay, peninsula of Alaska, on the island of Unalaska on the N.N.W., foot of Mt. Makushiuski.

Mastodon bones and teeth are found at Escholtz bay, Kotzebue sound, and on the Pribulow islands.

Of the interior topography of the country little is known; recent explorations made by Mr. Dall, who has explored the Youkon river extensively, will undoubtedly give us more authentic and reliable information in regard to that than any heretofore available.

San Francisco, January, 1868.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On the specific magnetism of iron;* by PLINY EARLE CHASE.*—In my communication on the numerical relations of gravity and magnetism (Trans. A. P. S., vol. xiii, p. 126), after adducing various evidences of a correlation that had been long suspected, I endeavored to obtain approximate valuations for the constant factor, K, which was introduced in the comparison of the tidal forces with the force of equilibrium. These approximations led me to "suggest the

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* *From the Proceedings of the* American Philosophical Society, Nov. 15, 1867.

propriety of considering the element of density (or of its correlative, the square of the time of molecular diffusion), in connection with both A and M."

In the year after this suggestion was made, Dr. Menzzer announced, as an experimental result (Poggendorf's Annalen, Nov. 1865; P. Mag., xxx, 456), "that "the magnetizing powers of two coils which give the maximum of intensity are as the square roots of their weights."

It therefore appears,

1. From Graham's and other well-known laws:
    - Elasticity $\propto$ specific heat $\propto$ (wave velocity)^2.
    - Density $\propto$ (time of molecular diffusion)^2.
    - Weight $\propto$ (time of sonorous vibration)^2.
2. From observations on terrestrial magnetism:
    - Tidal differences $\propto$ (magnetic differences)^2.
    - Magnetic variation $\propto$ (time)^2.
3. From Menzzer's experiments:
    - Weight $\propto$ (magnetizing power)^2.

This indirect confirmation, of a conjecture which was at first based on a plausible analogy, encourages me to hope that the following comparisons between molecular and cosmical kinetic values may help to explain the specific magnetism of iron.

According to Tredgold, iron may be elongated about $\frac{1}{1400}$ without permanent alteration of structure. Now the ratio, at the earth's surface, of solar terrestrial attraction, is about $\frac{1}{1640}$, and four times the ratio of the specific gravity of air to that of iron varies, approximately, between $\frac{1}{1400}$ and $\frac{1}{1700}$. Although this range of variation is somewhat more than $\frac{1}{5}$ of the least value, or about $\frac{1}{8000}$ of the total force, it is but little greater than Helmholtz found in the vibration-ratios for the first overtone of a series of tuning forks (5·8 to 6·6 times the fundamental), while it is much less than the daily fluctuation in the terrestrial magnetic force, which appears to be intimately connected with the joint action of atmospheric elasticity and solar differential-tidal attraction.

The coefficient of atmospheric specific gravity, 4, suggests the ratio of the length of a sonant aerial column to that of an equivalent sonorous wave, as well as the time of a complete oscillation of each magnetic pulse. During each vibration, from a maximum of condensation across the position of equilibrium to minimum, or *vice versa*, the effect produced by any constant force would be four times as great as during the half oscillation, from either extreme to the point of equilibrium. The ratios of wave-velocity to elasticity and density, and of revolution to distance from the center of motion, point to various experiments upon the relations of magnetic capacity to tenacity, in iron, and of magnetizing power to specific gravity or to specific heat,* in coils of different metals.

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* The specific heats of iron, cobalt, and nickel are nearly the same, being each about 27 times that of hydrogen. Recently discovered cosmical affinities of hydrogen and iron, and the ratio between solar and terrestrial superficial gravitation, *may, perhaps*, sometime lead to the recognition of a significance in relations which would now be generally regarded as fanciful and accidental.

If such experiments should show any intimate connection between elasticity and specific magnetism (a result which it does not seem unreasonable to anticipate), some of the mystery in which an interesting physical fact is now shrouded will be happily dispelled.

2. *On a new synthesis of oxalic acid and its homologues.*—**Berthelot** has succeeded in converting acetylene, C_4H_2, into oxalic acid by the direct addition of oxygen,

$$C_4H_2+O_8=C_4H_2O_8.$$

As the same chemist had already shown that acetylene may be directly formed from its elements, the synthesis of oxalic acid requires but two successive operations. The oxydizing agent employed is hypermanganate of potash, the solution of which is to be added to the gas at the ordinary temperature and the liquid gradually shaken as long as the color disappears. The oxyd of manganese separated is then filtered off, when the filtrate will be found to contain a large quantity of oxalate of potash. As carbonic and formic acids are produced at the same time, the author regards these as resulting from the decomposition of the nascent oxalic acid,

$$C_4H_2O_8=C_2O_4+C_2H_2O_4.$$

In forming oxalic acid, one volume of acetylene takes up two volumes of oxygen, and Berthelot remarks that this is the first instance in which a hydrocarbon unites directly with oxygen without the elimination of any element.

Ethylene is oxydized by hypermanganate of potash almost as readily as acetylene, carbonic and formic acid are produced, together with a considerable quantity of oxalic acid. In this case we have the equation

$$C_4H_4+O_{10}=C_4H_2O_8+H_2O_2.$$

Allylene, C_6H_4, by oxydation with hypermanganate of potash in the cold yields malonic acid, $C_6H_4+O_8=C_6H_4O_8$. Acetic and carbonic acids are formed at the same time as products of the oxydation of malonic acid.

Propylene, C_6H_6, also yields malonic acid, but in larger quantity than allylene,

$$C_6H_6+O_{10}=C_6H_4O_8+H_2O_2,$$

oxalic, acetic, formic and carbonic acids are formed at the same time by a secondary oxydation. Amylene, $C_{10}H_{10}$, appears to yield a mixture of pyrotartaric, succinic and malonic acids. Styrolene yields benzoic and carbonic acids. Oil of turpentine yields a resinous acid and a neutral volatile substance having the odor of camphor.—*Comptes Rendus*, lxiv, p. 35. W. G.

3. *On Methylic Aldehyd.*—Dr. A. W. **Hofmann** has found that a substance possessing the composition and properties of methylic aldehyd is formed when a current of air charged with the vapor of methylic alcohol is directed upon an incandescent platinum spiral. The bottom of a strong three-necked bottle of two liters' capacity is covered to the height of about five centimeters with moderately warm methylic alcohol. The first neck is provided with a tube

descending to the very surface of the liquid; into the second is fixed a loosely-fitting cork which carries the platinum spiral, the third neck communicates with a condenser the lower end of which is fastened into a two-necked receiver. This is connected with a series of wash bottles and the last of these with a water-jet aspirator by which a current of air can be drawn through the whole system. The spiral is then heated to redness and plunged into the bottle. After a few minutes, irritating vapors are formed and drops of liquid soon condense in the receiver. If the current of air be properly adjusted, the platinum spiral remains incandescent for hours, and even for days, and there is no difficulty in collecting from 50 to 100 grams of a liquid rather rich in methylic aldehyd. In lecture-table experiments, a table blowpipe may be used in place of an aspirator to keep the whole spiral incandescent. A harmless explosion sometimes takes place which merely blows out the cork carrying the spiral of wire.

The liquid in the receiver has all the properties of a solution of methylic aldehyd. When rendered slightly alkaline by ammonia, it yields with nitrate of silver, a silver mirror of "irreproachable perfection." When heated with a few drops of a fixed alkali and boiled, the liquid becomes turbid and deposits drops of a brownish oil, possessing the odor of ethyl-aldehyde-resin. From want of time, the author has not yet isolated and analyzed methylic aldehyd, but has established its presence by preparing and analyzing the methylic sulph-aldehyd, $ЄH_2Ꞩ_2$ which is a beautiful white crystalline substance fusing at 218° C., and subliming without decomposition. The author promises a more complete examination of the new aldehyd, which can hardly fail to prove a most interesting substance.—*Proc. Royal Soc.*, xvi, 156. W. G.

4. *On Fraunhofer's lines and on the violet portion of the solar spectrum.*—ANGSTRÖM and THALEN have communicated to the Royal Swedish Academy of Sciences a memoir on the part of the solar spectrum between G and H, which is accompanied by a map, and serves to complete the work left unfinished by Kirchoff. The authors find that with a single prism of 60° filled with bisulphid of carbon, and with a magnifying power of 40, all the lines upon Kirchoff's chart, the faintest not excepted, may be distinctly seen. The charts attached to their memoir were obtained with such a prism. To obtain a greater intensity of light in the violet portion of the spectrum, the authors employed as a condenser an objective by Dollond of about 90 millimeters aperture and 3 meters in focal length. The image of the sun as thus concentrated was allowed to fall upon the slit of the condenser. In the neighborhood of the lines H and H_1, a colored glass was employed to exclude all foreign rays. The measurements were made partly by a glass micrometer introduced into the eye-piece and partly by a filar micrometer used whenever it was possible to illuminate the wires. The lines beyond H were too faint to be distinguished by the eye. The drawings were made by Thalén by hand, but the scale employed is a little larger than that of Kirchoff. By employing a large inductorium

the authors obtained a much greater number of iron-lines than had been observed by Kirchoff, principally in the blue portion of the spectrum. When, in place of the inductorium, a galvanic battery of fifty jars was used with metallic points for poles, a much greater number of lines was seen. For the iron lines the authors employed pieces of metal 10 millimeters in diameter; for the manganese spectrum, the poles were of pyrolusite. The coincidences between the metallic and solar lines were obtained by the well-known method of examining both spectra at once, each occupying half the field of view. In the space between A and G, Kirchoff and Hofmann found 73 iron lines corresponding to as many solar lines; this number the authors have increased to 220. In the interval between G and H the authors observed 170 lines, making the whole number of iron lines about 460, to which 100 or 200 others would have been added had not the feebleness of the sun's light compelled the authors to suspend their researches. Angström and Thalén consider it certain from their investigations that manganese and hydrogen exist in the sun's atmosphere. To the three hydrogen lines already known to exist, they have added a fourth which corresponds to the most remarkable line between G and H. The authors do not find any evidence of the existence of new elements in the sun's atmosphere. They consider it probable that with a larger battery, a much greater number of iron-lines would be observed, and insist upon the importance of determining what lines are due to the earth's atmosphere alone.—*Les Mondes*, xv, p. 238. W. G.

[*Note.*—With reference to the use of a single prism of bisulphid of carbon, it may be remarked that the authors do not give the dimensions either of the prism or of the telescopes employed, and that the power of a spectroscope greatly depends upon its size, or, in other words, upon the quantity of light. Compare upon this point, the remarks of Sigmund Merz (Pogg. Ann., cxvii, 654). With a flint glass prism of ·60° and sufficiently large to admit a bundle of rays 43 lines in thickness, and with a collimator of 34 lines aperture, Merz succeeded in resolving the line D into five.—W. G.]

5. *Carbonylic Sulphid.*—This body, intermediate between ЄΘ_2 and ЄꞨ_2, has been long foreseen. THAN has recently succeeded in forming it and in determining its properties. He first attempted its direct synthesis by passing carbonous oxyd ЄΘ, and sulphur vapor through a red-hot porcelain tube. A considerable quantity was thus produced, but it could not readily be separated from the excess of carbonous oxyd. Moreover it was decomposed again by the heat into its constituents. Recalling then the fact that cyanic acid, by taking up the elements of water, was decomposed into carbonic dioxyd and ammonia according to the equation

$$(\text{ЄΘ})''\text{HN}+\text{H}_2\text{Θ}=\text{H}_3\text{N}+\text{ЄΘ}_2$$

(in which cyanic acid is viewed as the imid of carbonic acid), Than saw that analogy required a similar decomposition for sulpho-cyanic acid thus:—

$$(\text{ЄꞨ})''\text{HN}+\text{H}_2\text{Θ}=\text{H}_3\text{N}+\text{ЄΘꞨ}.$$

Experiment confirmed this theoretic view. By the action of strong sulphuric acid, the sulphocyanates take up $H_2\Theta$ and yield the gas with effervescence. The method of its preparation is as follows:

Into a cooled mixture of five volumes concentrated sulphuric acid and four volumes of water, is placed as much potassic sulphocyanate as will allow the mass to remain fluid. The evolution of gas commences spontaneously; should it become too violent the flask may be cooled by placing it in water; and if toward the close of the action, it is too slow, a gas-flame may be put under it for a moment. Thus regulated, a constant stream of gas is obtained, which contains the vapor of water and of carbonic disulphid, as well as a trace of cyanhydric acid, and probably of formic acid. It is allowed to pass through three U tubes, the first of which contains cotton covered with moist mercuric oxyd to absorb the acids, the second, pieces of unvulcanized caoutchouc to remove the $\text{Ꞓ}\text{Ꞩ}_2$,* and the third calcic chlorid to dry the gas. It is then collected over mercury, upon which when dry it has no action, even after many days. The moist gas however, covers the mercury in a few hours with a thin coating of mercuric sulphid.

As thus prepared, carbonylic sulphid is a colorless gas, with an odor not dissimilar to that of $\text{Ꞓ}\Theta_2$, but at the same time aromatic, recalling perhaps that of $H_2\text{Ꞩ}$, though not at all disagreeable. It is soluble in its own volume of water, to which it communicates its odor. The taste of this solution is distinctly sweet, followed immediately by a peculiar prickly sulphur taste resembling that of $H_2\text{Ꞩ}$ and of $\text{Ꞩ}\Theta_2$ together. After a few hours, however, the solution exhales a strong odor of $H_2\text{Ꞩ}$. It is twice as heavy as air and may be poured from one vessel to another. It reddens litmus feebly, much more so than $\text{Ꞓ}\Theta_2$. When ignited it burns with a beautiful blue slightly luminous flame, yielding $\text{Ꞓ}\Theta_2$ and $\text{Ꞩ}\Theta_2$. It takes fire very readily, even by a spark on a match. If the jar be held with the mouth downward, the gas burns completely; but if it be reversed, and a taper be introduced, the gas takes fire, while the taper is extinguished, and again relighted at the mouth of the jar. Under these conditions the combustion is incomplete and sulphur is deposited. A cold and dry beaker-glass held over a jet of the burning gas, shows no trace of moisture. With 1½ vols. of oxygen, it forms an explosive mixture. Potassic hydrate absorbs the gas completely, though more slowly than $\text{Ꞓ}\Theta_2$. Dilute acids evolve $H_2\text{Ꞩ}$ and $\text{Ꞓ}\Theta_2$ from this solution, so that the absorption appears to take place thus: $\text{Ꞓ}\Theta\text{Ꞩ}+(HK\Theta)_4=K_2\text{Ꞓ}\Theta_3+K_2\text{Ꞩ}+(H_2\Theta)_2$. The potash solution gives a copious black precipitate with ammonio-argentic nitrate; no trace of cyanogen was found in the filtrate.

Neither chlorine nor fuming nitric acid have any action upon the gas at ordinary temperatures. Passed over heated mercury in a bulb-tube, no change is observed, though if long boiled in the gas a trace of mercuric sulphid is formed. When sodium is treated in the same way, a white crust is produced at the common temperature, which by heating easily melts and becomes darker. At a low red heat the sodium ignites, burning with a brilliant light and leaving a black easily fusible mass, containing no trace of sodic cyanid, thus proving the absence of nitrogen in the gas.

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* *The success of this device is so great that Than recommends its use in all similar cases. The $\text{Ꞓ}\text{Ꞩ}_2$ is completely removed.*

When passed through mercuric-ethyl, at near its boiling point, a violent action takes place, pure metallic mercury without a trace of sulphid is separated, and a yellow liquid is produced, having a strong garlic odor. The author supposes it to be ethylic sulphopropionate.

If heated to low redness the gas is decomposed. This fact may be used to determine its composition as follows:—

Near the closed end of a U tube, a fine platinum wire is fused, stretching across the tube. This arm being filled with the gas over mercury, and its volume ascertained, the wire is maintained at a bright red heat by means of the battery. About the wire the gas is decomposed; thick heavy clouds of yellow sulphur-vapor fall down the tube till the decomposition is complete. After cooling, the residual gas possesses the original volume. It is odorless, does not render baryta-water turbid and burns with a pale blue flame; the product of the combustion renders baryta-water at once milky. It is hence carbonous oxyd.

	Milligrams.
Since, therefore, 1 vol. (22·33 c. c.) carbonylic sulphid weighs	60
and 1 vol. (22·33 c. c.) carbonous oxyd weighs	28
The weight of the sulphur in the gas is	32

The gas contains therefore one atom of Ꞓ, one of Ɵ, and one of Ꞩ, and its formula is ꞒƟꞨ.

Two determinations of its density were made by Bunsen's method. The first however was on a portion of the gas before the use of the tube containing caoutchouc; it retains therefore a trace of ꞒꞨ_2 vapor. The observed density is 2·1152 and 2·1046 in the two experiments; the calculated is 2·0833. 60 is therefore its molecular weight. These results were confirmed by direct analyses of the gas, made according to Bunsen's methods.

In the opinion of the author, this gas is quite widely distributed in nature. Because it is so easily decomposed by water into ꞒƟ_2 and $\text{H}_2\text{Ꞩ}$, however, it has generally been confounded with these substances. From some experiments of his own, Than thinks he he can assert almost positively that this compound is contained in the new and remarkable thermal spring of Harkány; and also in the cold sulphur-spring of Parád, both in Hungary. He sustains this view by the fact that the water freshly drawn has precisely the odor of the gas, which recalls, but cannot at all be mistaken for that of $\text{H}_2\text{Ꞩ}$; though on standing a few hours, the sulphydric acid odor appears. For these reasons it is probable that it occurs in many other sulphur springs, and it can scarcely be doubted that it could be found among the sulphur-gases of volcanic action, and perhaps in those arising from organic decomposition.

It is recognized by the following reactions: 1st, Potassic hydrate deprives the gas or its watery solution, at once, of its peculiar odor. The alkaline solution effervesces with dilute sulphuric acid, evolving H_2S (distinction from C^2S). 2nd, in acid solutions of silver or cadmium it produces no precipitate; but upon the addition of ammonia, the respective sulphids appear (distinction from H_2S). 3rd, Sodic nitro-ferri-cyanid has no action in neutral or acid solutions; but an intense blue-violet color is developed by potash or ammonia. 4th, Iodid of starch is decolorized in a short time by this gas.—*Ann. Ch. Pharm.*, *Suppl.*, Band V, 236, *Oct.* 1867. G. F. B.

6. *Manufacture of sodic carbonate.*—**Kessler**'s patent process consists in heating salt, mixed with chromic oxyd (manganic dioxyd, plumbic or ferrous chromate may also be used) to redness in a current of steam, producing HCl and Na_2CrO_3. The mass is drawn from the fire, mixed with charcoal and again heated; by which Na_2CO_3 and Cr_2O_3 are produced. The sodic carbonate is extracted with water, and crystallized. The chromic oxyd is ready for a new operation.—*Bull. Ch. Soc.*, II, viii, 290, *Oct.* 1867.

G. F. B.

7. *Allotropic states of Metallic Arsenic.*—When arsenicum is sublimed in a stream of hydrogen gas, there is obtained, beside the sublimate of hexagonal crystals, having a metallic luster, a black vitreous amorphous mass, and also a fine gray powder. **Bettendorf** has investigated the conditions under which these are produced, and finds that they are dependent upon the temperature. When pure arsenicum is sublimed in a quick stream of hydrogen gas, the hexagonal variety is deposited nearest to the heated part of the tube, next amorphous black metal is thrown down, while the anterior portion of the tube is filled with a bright yellow smoke, which is deposited of a darker yellow color, and becomes finally gray. Under the microscope, this gray powder is amorphous, and consists of minute adherent spheres. Its density at 14° C., is 4·71, and it is easily oxydized by dilute nitric acid. Heated to 358° or 360°, it passes so rapidly into the crystallized variety (sp. gr. 5·72) that a portion of it is sublimed by the heat evolved. The author has not yet been able to preserve the yellow modification, as it passes rapidly into the gray.

The amorphous glassy black arsenicum is obtained when the vapor is cooled to 210° or 220° C. It is readily procured in crusts 5 or 6 millimeters thick, by subliming the metal in a stream of hydrogen, through a tube, one portion of which is bent in a U form, and maintained at 220° by an oil bath. Its sp. gr. is 4·71, and it passes at 360° into the crystalline variety with an evolution of heat. It is not easily tarnished, nor attacked by chemical agents, dilute nitric acid being without action upon it. It constitutes the arsenical mirror of the Marsh test.

The density of the hexagonal variety was found to be in three specimens prepared by different methods 5·728, 5·726, 5·727 at 14° C.—*Ann. Ch. Pharm.*, cxliv, 110, *Oct.*, 1867. G. F. B.

8. *Metallic Cerium.*—**Wöhler** has recently prepared this metal

by igniting the double chlorid of cerium and potassium with sodium. Metallic globules weighing 50 to 60 milligrams were thus obtained which consisted essentially of cerium. The color of cerium is between that of iron and lead; when cut and polished it has a strong luster. It is malleable and sectile. Its sp. gr. is 5·5 at 12° C.: but this is only an approximation. In the air it is slowly tarnished at ordinary temperatures, acquiring a bluish tinge. At 100° C. it decomposes water feebly, evolving hydrogen. It is easily attacked by acids; being converted by nitric acid into bright brown ceric oxyd. When heated in the air to weak ignition, it burns brilliantly to oxyd; but if suddenly heated more strongly, it burns with explosive violence, throwing about a brilliant shower of fire. In the pulverulent state it takes fire even at 100° C.

When the slag, from which the metallic globules had been separated, was treated with water, a glistening purple powder was left, which was purified by digestion with dilute chlorhydric acid. The dark-purple residue consisted of minute lustrous crystalline plates which upon analysis gave cerium 72·20, chlorine 18·38, oxygen 8·41=98·99; giving the formula $CeCl+2CeO$. [Or $\text{Ͼe}_3(\Theta_2\text{Cl}_2)$, the dichlorhydrin of di-meta-tri-ceric base].—*Ann. Ch. Pharm.*, cxliv, 251, *Nov.* 1867. G. F. B.

9. *Delicate test for alkalies.*—According to BOETTGER, the coloring matter of the ornamental plant so common in our gardens, called *Coleus Verschaffelti*, is readily turned green by alkalies. By digesting the fresh leaves in cold absolute alcohol to which a few drops of sulphuric acid have been added, for 24 hours, a solution is obtained from which paper of a fine red color may be prepared. The color is not affected by carbonic acid, and hence it readily detects the presence of earthy carbonates in natural waters. Its sensibility is very great; a piece of the paper held in the flame of illuminating gas, is at once turned green by the ammonia present.—*J. Pr. Ch.*, ci, 290, 1867. G. F. B.

10. *Method for the direct determination of oxygen in organic analysis.*—VON BAUMHAUER uses a combustion tube, 70 to 80 centimeters in length, in which he places: 1st, a column of copper-turnings 20 c. m. long; 2d, 10 c. m. of broken porcelain; 3d, 25 c. m. of cupric oxyd, in pieces of the size of wheat, strongly calcined (separating this from the layers before and behind it, by asbestus); 4th, the substance to be analyzed, placed in a small boat; and 5th, at a distance of 6 or 7 c. m. from this, another boat containing a weighed quantity of argentic iodate. This extremity of the tube communicates with two gas holders, from which either pure hydrogen or pure nitrogen can be supplied at pleasure. The operation is commenced by passing a slow stream of hydrogen through the tube, and applying heat to the copper turnings, to reduce any oxyd present. The hydrogen is then completely removed by a current of nitrogen, and the ordinary apparatus for the absorption of the $\text{Ͼ}\Theta_2$ and the $H_2\Theta$ is attached. The combustion is proceeded with in the usual way, and when it is finished, the argentic iodate is gradually heated. The oxygen thus evolved, burns any remain-

ing carbon and reoxydizes the copper, reduced from the oxyd; any excess is retained by the copper-turnings. When the silver salt is entirely decomposed, the current of nitrogen is re-established. When cold, the absorption apparatus is weighed as usual. A fresh calcic chlorid tube is now attached, a current of hydrogen is sent through the apparatus, and the copper-turnings are heated. The oxyd formed by the excess of oxygen from the iodate, is now reduced; and the water which results is collected in the calcic chlorid tube. From this water, the amount of oxygen yielded by the iodate, in excess of that needed to burn the organic matter, is readily calculated. If this excess be subtracted from the whole of the oxygen evolved from the iodate (a known quantity of which was taken), the remainder is the quantity of oxygen required to burn the body, in addition to the oxygen which the body itself contained. If therefore from the whole oxygen found in the products of the combustion, viz., the ЄӨ_2 and the $\text{H}_2\text{Ө}$, this quantity be subtracted, there will remain the amount of oxygen in the substance analyzed. For example: ·452 grm. oxalic acid and 1·256 grms. AgIӨ_3 were taken, ·443 grm. ЄӨ_2 and ·090 grm. $\text{H}_2\text{Ө}$ were obtained. The second portion of water weighed ·1495 grm., corresponding to ·133 grm. oxygen. As 1·256 grms. argentic iodate evolved ·2125 grm. oxygen, ·2125 – ·133 = ·0795 grm., the quantity of oxygen used to complete the combustion. In the ·443 grm. ЄӨ_2 and the ·090 grm. $\text{H}_2\text{Ө}$ there are ·4022 grm. oxygen, the whole amount needed to burn the body. Of this the argentic iodate furnished ·0795 grm.; hence the substance itself yielded ·4022 – ·0795 = ·3227 grm. oxygen. The ·452 gram of oxalic acid contains therefore carbon ·1208, hydrogen ·010, oxygen ·3227; which gives as the percentage composition carbon 26·73, hydrogen 2·21, oxygen 71·39 = 100·33. The calculated values are carbon 26·66, hydrogen 2·23, oxygen 71·11 = 100.

An equally ingenious process for the simultaneous determination of the nitrogen is also given.—*Archives Néerlandaises*, i, 179, 1866. G. F. B.

11. *On Glycerin and its derivatives.*—Buff has published a short but interesting paper upon the rational constitution of these bodies. Starting with the fact that glycerin must contain one alcohol-residue $\text{ЄH}_2\text{–ӨH}$, because of the production of glyceric acid, containing the corresponding acid-residue, ЄӨ–ӨH from it, by oxydation; and again, that the production of isopropylic iodid by Erlenmeyer, by the action of phosphoric iodid upon glycerin, demonstrates that at least one hydryl-atom is united to the middle carbon atom; and therefore that two formulas for glycerin are possible,

$$\left\{\begin{array}{l}\text{ЄH}_2\text{–ӨH}\\ \text{ЄH–ӨH}\\ \text{ЄH}_2\text{–ӨH}\end{array}\right. \text{ or } \left\{\begin{array}{l}\text{ЄH}_3\\ \text{Є(ӨH)}_2\\ \text{ЄH}_2\text{–ӨH}\end{array}\right. \text{; as well as } \left\{\begin{array}{l}\text{ЄH}_2\text{–ӨH}\\ \text{ЄH–ӨH}\\ \text{ЄӨ–ӨH}\end{array}\right. \text{ or } \left\{\begin{array}{l}\text{ЄH}_3\\ \text{Є(ӨH)}_2\\ \text{ЄӨ–ӨH}\end{array}\right.$$

for glyceric acid, Buff goes on to decide between them. If glyceric acid had the latter formula, then it is evident that by replacing the two atoms of hydryl (which are united to the middle *carbon* atom), one by H, and the other by Cl, a chlorpropionic acid of the constitution $\left\{\begin{array}{l}\text{ЄH}_3\\ \text{ЄHCl}\\ \text{Єϴ–ϴH}\end{array}\right.$ would be formed. This acid corresponds to the ordinary lactic acid $\left\{\begin{array}{l}\text{ЄH}_3\\ \text{ЄH–ϴH.}\\ \text{Єϴ–ϴH}\end{array}\right.$ Wichelhaus has, however, shown that glyceric acid treated with phosphoric chlorid does not produce this chlorpropionic acid, but one isomeric with it. Of course (assuming the equality of the four carbon units of attraction), this can only be the chlorpropionic acid corresponding to sarco-lactic acid, $\left\{\begin{array}{l}\text{ЄH}_2\text{–ϴH}\\ \text{ЄH}_2\\ \text{Єϴ–ϴH}\end{array}\right.$ whose constitution is $\left\{\begin{array}{l}\text{ЄH}_2\text{Cl}\\ \text{ЄH}_2\\ \text{Єϴ–ϴH}\end{array}\right.$. Hence the formula of glyceric acid must be $\left\{\begin{array}{l}\text{ЄH}_2\text{–ϴH}\\ \text{ЄH–ϴH}\\ \text{Єϴ–ϴH}\end{array}\right.$ and that of glycerin $\left\{\begin{array}{l}\text{ЄH}_2\text{–ϴH}\\ \text{ЄH–ϴH}\\ \text{ЄH}_2\text{–ϴH}\end{array}\right.$. The action of phosphoric chlorid, then, substitutes chlorine for a hydryl-atom, belonging, not to an acid, but to an alcohol residue; producing a body different from the bromine-compound obtained by the direct action of bromine upon propionic acid. In this body, as Buff has shown, the bromine is attached to the middle carbon atom, giving the formula $\left\{\begin{array}{l}\text{ЄH}_3\\ \text{ЄHBr}\\ \text{Єϴ–ϴH}\end{array}\right.$, which may be compared with that of the chlorpropionic acid of Wichelhaus, given above.

To which of these forms do the chlorhydrins belong? Is the chlorine in monochlorhydrin attached to the middle or to one of the end carbon-atoms? This question Buff has answered by reducing monochlorhydrin by means of sodium-amalgam. A colorless, odorless liquid was obtained, boiling between 185° and 190°, corresponding precisely to propylenic glycol. Since this body by simple oxydation yields the ordinary lactic acid, the latter will fix its molecular constitution. In order to decide this point, the conversion into lactic acid was effected by means of platinum-black; and the lactic acid thus formed was converted into the zinc salt, and its character established. It is hence certain that in the action of chlorhydric acid upon glycerin, the chlorine replaces a hydryl-atom belonging to an external carbon-atom, thus:

Glycerin.	Monochlorhydrin.	Propylenic glycol.	Lactic acid.
$\left\{\begin{array}{l}\text{ЄH}_2\text{–ϴH}\\ \text{ЄH–ϴH}\\ \text{ЄH}_2\text{–ϴH}\end{array}\right.$	$\left\{\begin{array}{l}\text{ЄH}_2\text{Cl}\\ \text{ЄH–ϴH}\\ \text{ЄH}_2\text{–ϴH}\end{array}\right.$	$\left\{\begin{array}{l}\text{ЄH}_3\\ \text{ЄH–ϴH}\\ \text{ЄH}_2\text{–ϴH}\end{array}\right.$	$\left\{\begin{array}{l}\text{ЄH}_3\\ \text{ЄH–ϴH}\\ \text{Єϴ–ϴH}\end{array}\right.$

In dichlorhydrin, a similar reduction would produce, according as the second atom of chlorine is united to the middle or to the outer carbon atom, propylic or isopropylic alcohol, thus:—

$$\left\{\begin{array}{l}\text{Є}H_2Cl\\ \text{Є}HCl\\ \text{Є}H_2\text{–}\Theta H\end{array}\right. = \underset{\text{Propylic alcohol.}}{\left\{\begin{array}{l}\text{Є}H_3\\ \text{Є}H_2\\ \text{Є}H_2\text{–}\Theta H\end{array}\right.} \qquad \left\{\begin{array}{l}\text{Є}H_2Cl\\ \text{Є}H\text{–}\Theta H\\ \text{Є}H_2Cl\end{array}\right. = \underset{\text{Isopropylic alcohol.}}{\left\{\begin{array}{l}\text{Є}H_3\\ \text{Є}H\text{–}\Theta H\\ \text{Є}H_3\end{array}\right.}$$

This reduction, effected by sodium-amalgam, yielded a clear mobile fluid, boiling from 82° to 85°, corresponding in composition and properties to isopropylic alcohol. To confirm this view, it was oxydized by sulphuric acid and potassic dichromate, and yielded acetone. These bodies may be thus represented:—

$$\begin{array}{lllll}\text{Glycerin.} & \text{Monochlorhydrin.} & \text{Dichlorhydrin.} & \text{Isopropylic alcohol.} & \text{Acetone.}\\ \left\{\begin{array}{l}\text{Є}H_2\text{–}\Theta H\\ \text{Є}H\text{–}\Theta H\\ \text{Є}H_2\text{–}\Theta H\end{array}\right. & \left\{\begin{array}{l}\text{Є}H_2Cl\\ \text{Є}H\text{–}\Theta H\\ \text{Є}H_2\text{–}\Theta H\end{array}\right. & \left\{\begin{array}{l}\text{Є}H_2Cl\\ \text{Є}H\text{–}\Theta H\\ \text{Є}H_2Cl\end{array}\right. & \left\{\begin{array}{l}\text{Є}H_3\\ \text{Є}H\text{–}\Theta H\\ \text{Є}H_3\end{array}\right. & \left\{\begin{array}{l}\text{Є}H_3\\ \text{Є}\Theta\\ \text{Є}H_3\end{array}\right.\end{array}$$

—*Ann. Ch. Pharm.*, *Suppl. Band* V, 247, 1867. G. F. B.

12. *The organic base, Neurine.* (a.) *Its discovery.*—In October, 1864, Liebreich (Ann. Ch. Pharm., cxxxiv, 29) obtained from an alcoholic extract of the brain, a crystallized substance having the composition $\text{Є}_{116}H_{241}N_4\Theta_{22}P$, to which he gave the name Protagon. On boiling this body with baric hydrate for 24 hours, it was decomposed, and yielded glycero-phosphoric acid, two or more of the fatty acids, and a new basic substance which he called neurine (νεῦρον). He prepared this base by precipitating the solution, after moderate concentration, with plumbic acetate, filtering from the plumbic glycero-phosphate, removing the excess of lead by H_2S, evaporating to dryness with the addition of oxalic acid to expel the acetic acid, removing the oxalic acid by digestion with baric carbonate, and filtering. The filtrate which reacted strongly alkaline, was exactly neutralized with chlorhydric acid, evaporated to a syrupy consistence and treated with $PtCl_4$; upon the addition of absolute alcohol, a bright to orange-yellow precipitate was thrown down, which was filtered off, and washed with absolute alcohol. This precipitate is neurine platino-chlorid. In this form it consists of microscopic needles; but when crystallized from water, it appears in six-sided tables, heaped upon each other like ureic nitrate. Liebreich's analysis of this body yielded the formula, $(\text{Є}_5H_{14}NCl)_2PtCl_4$. By H_2S the platinum is removed and the neurine chlorhydrate obtained, which crystallizes in silky needles, remarkably hygroscopic.

(b.) *Its rational constitution.*—More than two years after this, Baeyer (Ann. Ch. Pharm., cxl, 206, Dec. 1866) published some investigations upon neurine. He prepared this base by Liebreich's method, obtaining the chlorhydrate in hygroscopic needles. The platinum-salt separated in large yellow prismatic crystals, upon evaporating its aqueous solution in a vacuum. Alcohol threw down from this solution the same salt in yellow granular crystals; and upon long standing, still a third portion separated. These three products, however, gave different results upon analysis; (1) gave $(\text{Є}_5H_{14}N\Theta Cl)_2PtCl_4$, (2) $(\text{Є}_5H_{12}NCl)_2PtCl_4$, (3) $(\text{Є}_5H_{14}NCl)_2PtCl_4$. This result led Baeyer to the opinion that neurine was a compound of two or more bases. In order to unravel its constitution, he heated a moderately concentrated solution of the chlorhydrate with strong iodhydric acid and some red phosphorus,

ıme hours to 120° to 150° C. in a sealed tube. On cooling, a
derable number of large colorless prismatic crystals separated,
ı had the composition $Є_5H_{13}NI_2$. The iodine in this com-
l existed in two states of combination, since upon the addition
gentic nitrate, only a single atom separated as argentic iodid.
n digested with argentic chlorid, one-half the iodine was re-
d by chlorine, giving $Є_5H_{13}NICl$. Heated with freshly pre-
l argentic oxyd, both iodine-atoms were removed, and the
$Є_{10}H_{26}N_2ΘCl_2$ resulted. These reactions suggested the
ırity of this substance to a compound obtained by A. W. Hof-
ı by treating trimethylamine with ethylenic bromid, having
omposition $Є_5H_{13}NBr_2$. By acting upon this artificially pre-
l body with an excess of iodhydric acid, Baeyer obtained a
ance, $Є_5H_{13}NI_2$, identical in properties with the compound
ned from neurine. From this coincidence and that of other
ıounds, Baeyer concluded that neurine was a tri-methylized
ance; and since the iodine-compound $Є_5H_{13}NI_2$ is only
$H_3)_3(Є_2H_4I)I$, the base itself must be either trimethyl-vinyl-
onic hydrate, $N(ЄH_3)_3(Є_2H_3)HΘ$, or trimethyl-oxethyl-am-
c hydrate, $N(ЄH_3)_3(Є_2H_4[HΘ])HΘ$. He suggests that the
tion in the analyses may be due to the presence of both these
əs. He also calls attention to the facility with which neurine
res trimethylamine, as a possible mode of origin of this body
e animal organism. He remarks farther that this oxethyl
p $Є_2H_4(HΘ)$ exists in taurin; and thinks choline from the
and sinkaline from the white mustard-seed are probably identi-
rith neurine.

) *Neurine and choline identical.*—In March, 1867, DYBKOWSKY
ır. Ch., c, 153) published a paper upon the identity of choline
neurine. He noticed that when the aqueous solution of the
no-chlorid of either of these bases was concentrated in a vacu-
ıver sulphuric acid, two kinds of crystals appeared. One kind
long-pointed, six-sided, orange-red crystals in thin tables; the
rs were yellow octahedrons; these latter were less soluble in
r than the former. He considers the latter a decomposition-
uct of the former salt; and says it is formed more abundantly
nore slow the evaporation. The purest crystals, which ap-
ed entirely free from the octahedrons, were selected for com-
ion. And from the results, the formula $(Є_5H_{14}NΘCl)_2PtCl_4$,
tical with Baeyer's first formula, was deduced.* Besides the

Dybkowsky calls attention to Baeyer's description of his platinum-salt in
ge yellow prismatic crystals," obtained by evaporation, and in "yellow gran-
crystals," by precipitation with alcohol; and says that the product thus
ned was not the pure neurine-salt, since this is not yellow, but orange-red,
alls, on the addition of alcohol, in amorphous flocks. The product of its de-
osition, however, just described, crystallizes in yellow octahedrons, which
be so united together as to resemble a prism; but this crumbles readily to oc-
lrons. This too is the body which alcohol precipitates as a crystalline pow-

[It is to be remarked that some of Baeyer's analyses sustain the formula
$_{12}NCl$ for the chlorhydrate, which is $(ЄH_3)_3(Є_2H_3)NCl$ or the vinyl compound;
ə others give $Є_5H_{14}NOCl$, or $(ЄH_3)_3(Є_2H_4[HO])NCl$, the oxethyl base.
ɔ these *bodies differ only by* H_2O, may it not be that the prolonged evapora-
changes in this way the orange-red oxethyl neurine base into the yellow vi-
ompound?—B.]

fact that the physical and chemical properties of choline and neurine are precisely alike, Dybkowsky confirms their identity by quoting a statement from Naumann upon the coincidence of the crystalline form of the two platino-chlorids. The paper ends with some reasons for supposing that protagon exists in the bile, and is there the parent of the choline, as it is known to be of neurine in the brain-extract.

(d.) *Its rational formula established.*—In a more recent paper, Baeyer (Ann. Ch. Pharm., cxlii, 322, June, 1867) has published some farther investigations upon neurine. Concluding from his previous experiments, that the platino-chlorid was variable in composition (though in what way he does not state, not having seen Dybkowsky's paper apparently), he examined the precipitate, first obtained by Liebreich, produced by adding a solution of gold to a not too dilute solution of neurine chlorhydrate. This precipitate consists of yellow microscopic needles, difficultly soluble in cold but readily in hot water, being deposited when the solution cools in brilliant yellow needles; and on spontaneous evaporation in long well formed prisms. These gave upon analysis the formula $\text{Є}_5H_{14}N\text{Ɵ}Cl, AuCl_3$ the composition being quite uniform. The presence of oxygen excludes the vinyl hypothesis and fixes the constitution of neurine as trimethyl-oxethyl ammonic hydrate $\left.\begin{matrix}(\text{Є}H_3)_3(\text{Є}_2H_4[H\text{Ɵ}])N\\ H\end{matrix}\right\}\text{Ɵ}$; the chlorhydrate being $(\text{Є}H_3)_3(\text{Є}_2H_4[H\text{Ɵ}])NCl$. Iodohydric acid at a high temperature converts this body into trimethyl-iodethyl-ammonic iodid, $(\text{Є}H_3)_3(\text{Є}_2H_4I)NI$. This iodid corresponds precisely with the bromid artificially prepared by Hofmann, and, as already stated, may be produced from it. On treating either the natural or the artificial iodid with excess of argentic oxyd, however, instead of replacing I by $(H\text{Ɵ})$ as was expected, HI is abstracted, and trimethyl-vinyl-ammonic hydrate $(\text{Є}H_3)_3(\text{Є}_2H_3)NH\text{Ɵ}$, instead of trimethyl-oxethyl-ammonic hydrate $(\text{Є}H_3)_3(\text{Є}_2H_4[H\text{Ɵ}])NH\text{Ɵ}$, is produced. The oxethyl base is more easily re-converted into the iodid than the vinyl base. Hence it appears that while neurine can readily be converted into the vinyl compound of Hofmann, the reverse process cannot be effected; at least, with argentic oxyd; this is the more remarkable, since its lower homologue, the oxymethyl compound, is easily so converted. The gold salt of the vinyl compound has the formula $\text{Є}_5H_{12}NCl, AuCl_3$; hence the salt previously described by Baeyer as $\text{Є}_{10}H_{26}N_2\text{Ɵ}Cl_2$ consists of two molecules of the chlorhydrate with one of crystal-water $(\text{Є}_5H_{12}NCl)_2+H_2\text{Ɵ}$. As the oxethyl and the vinyl base differ only by $H_2\text{Ɵ}$, may not neurine be the vinyl compound with a molecule of crystal-water? To settle this question, Baeyer treated dry neurine chlorhydrate with acetylic chlorid. The gold compound of the body thus produced, gave on analysis the formula $\text{Є}_7H_{16}N\text{Ɵ}_2Cl, AuCl_3$; or rationally $(\text{Є}H_3)_3(\text{Є}_2H_4[\text{ƟЄ}_2H_3\text{Ɵ}]NCl, AuCl_3$; being neurine in which one atom of hydrogen is replaced by acetyl. The existence in this base of the oxethyl group, $\text{Є}_2H_4(H\text{Ɵ})$, is thus demonstrated. Baeyer suggests its synthesis by the action of methylic iodid upon Wurtz's oxethylamine.

(e.) *Identity of neurine and sinkaline.*—In September, 1867, A. Claus and C. Keese published (J. pr. Ch., cii, 24) some researches on the identity of neurine and sinkaline. For the preparation of the former, they extracted the finely divided brain with a mixture of equal volumes alcohol and ether, decomposed this extract directly with baric hydrate, and distilled off the alcohol and ether on the water bath, continuing the heating for 24 hours. 8 calves-brains, treated in this way yielded as much neurine as 18, treated by the method of Dybkowsky. The excess of barium was removed by $\text{Є}\Theta_2$, the filtered fluid was evaporated to a syrupy consistence and extracted with alcohol. This alcoholic extract was acidulated with chlorhydric acid, and precipitated with an alcoholic solution of platinic chlorid. A voluminous yellow clumpy mass was thrown down which was dissolved in hot water and allowed to evaporate spontaneously. A more or less distinctly crystalline mass was thus obtained, which consisted of three substances. The larger portion was neurine platino-chlorid, which was separated from the other two bodies by fractional solution. One of these consisted of distinct octahedrons and dissolved slowly in boiling water, from which it again crystallized on cooling. This body the authors conclude to be potassium or ammonium platino-chlorid, though they were unable to obtain the crystals free from organic matter. The other body, very soluble in cold water, was not examined.

They confirm previous statements of the appearance of the crystals of the neurine-salt; and add that when to their aqueous solution, a small quantity of platinic chlorid is added, the crystalline form changes to a rhombic prism. This behavior is also characteristic of sinkaline; the authors therefore compared the neurine platino-chlorid, with specimens of the sinkaline-salt furnished by von Babo, its discoverer. The crystals of the neurine-salt, formed in presence of an excess of platinic chlorid, coincided completely with those of the sinkaline-salt, not only in form but in angular measurement.

The auro-chlorids were also found to be identical in properties. The salts of both bases behave alike on heating and evolve the characteristic odor of trimethylamine.

(f.) *Synthesis of neurine.*—On the 16th of Dec. last, Wurtz made a communication to the French Academy upon the synthesis of neurine. He first attempted its production by the method suggested by Baeyer, by treating oxethyl-ammonic hydrate with methylic iodid. But though successful, the yield was very small. Its direct synthesis was then accomplished by uniting trimethylamine with glycolic chlorhydrin,

$$\left\{\begin{matrix}\text{Є}H_2H\Theta\\ \text{Є}H_2Cl\end{matrix}\right. + \left.\begin{matrix}\text{Є}H_3\\ \text{Є}H_3\\ \text{Є}H_3\end{matrix}\right\}N = \left.\begin{matrix}(\text{Є}_2H_4[H\Theta])'\\ \text{Є}H_3\\ \text{Є}H_3\\ \text{Є}H_3\end{matrix}\right\}NCl.$$

Five grams of trimethylamine were heated with *ten grams of glycolic* chlorhydrin in a sealed tube in a water bath for 24 hours. The tube was then allowed to cool, when colorless prismatic crystals separated, which were easily soluble in hot absolute alcohol, from which, however, they were partially deposited on cooling. These crystals are trimethyl-oxethyl-ammonic chlorid, and are very deliquescent. Treated with auric chlorid, the double chlorid separates as a yellow precipitate, which is soluble in hot water, and crystallizes in characteristic needles on cooling. Wurtz has compared this auro-chlorid with the same body obtained from natural neurine and finds them identical. Platinic chlorid produces no precipitate even in concentrated solutions of the artificial chlorid, but the addition of alcohol gives a precipitate yielding 31·8 per cent of platinum, the theoretical quantity. Moist argentic oxyd converts this chlorid into the hydrate, yielding a strongly alkaline liquid becoming syrupy on concentration, and evolving an ammoniacal odor when heated.—*Chem. News*, xvii, 8, *Jan.* 3, 1868. G. F. B.

8. *Hydrocarbons of the Pennsylvania Petroleum;* by C. M. Warren, (from a letter to J. D. Dana, dated Brookline, 25 Feb., 1868.)—Your favor of the 24th instant has been received. It may be true that my formulæ for the bodies obtained from Pennsylvania petroleum require the corroborative evidence of the analytical results and vapor densities from which these formulæ were deduced in order to entitle them to be regarded as more trustworthy than those of Pelouze and Cahours. But I contend that the superiority of my process employed in making the separations, as evinced by the constancy of the boiling points, and uniformity of the boiling point difference for $ЄH_2$ throughout each series, should go far to establish for my work the claim of superiority. I should have included the analytical results and vapor densities above referred to, had it not seemed more appropriate that these should appear in a subsequent paper, which I hoped to publish shortly after;—the special object of my first paper being to consider the relation between elementary constitution and boiling-points in homologous series of hydrocarbons. Moreover, before publication of those results, I desired to repeat some of the elementary analyses, by my new process, in the hope of obtaining more exact results which might help to solve the question whether my 1st and 2d series should be considered isomeric. The facts that I had already obtained, although sufficient (as stated in the foot note p. 167 of my memoir) to raise a doubt on this point, would not justify different formulæ from those that I published.

I will give below a few of my analyses and vapor densities, including those of one or two members of each of my three series. I trust these may suffice for the present to show that my formulæ are well grounded, especially those of the 3d series, these being more at variance with those of Pelouze and Cahours.

1st series.—Oil of boiling point, 61°·3,

Specific gravity at 0°,	0·676
Vapor density found,	3·053
V. d. required for $\text{Є}_6\text{H}_{14}$,	2·974
The results of analysis gave	Є 83·88 H 16·58
	100·46
Theoretical numbers on $\text{Є}_6\text{H}_{14}$,	Є 83·72 H 16·28
	100·00

2d series.—Oil of boiling point, 68·°5.

Specific gravity at 0°,	0·689
Vapor density found,	3·038
Results of analysis,	Є 84·43 H 15·81
	100·24

Theoretical numbers as above.

3d series.—Oil of boiling point, 195·°8.

Specific gravity at 0°,	0·782
Vapor density found,	5·480
V. d. required for $\text{Є}_{11}\text{H}_{22}$,	5·327
Results of analysis,	Є 85·33 H 14·65
	99·98
Theoretical numbers on $\text{Є}_{11}\text{H}_{22}$,	Є 85·71 H 14·29
	100·00

Oil of boiling point, 216·°2.

Specific gravity at 0°,	0·791
Vapor density found,	6·164
V. d. required for $\text{Є}_{12}\text{H}_{24}$,	5·812
" " " $\text{Є}_{13}\text{H}_{26}$,	6·292
Results of analysis,	Є 85·74 H 14·66
	100·40
Theoretical numbers on $\text{Є}_{12}\text{H}_{24}$,	Є 85·71 H 14·29
	100·00
" " " $\text{Є}_{13}\text{H}_{26}$, the same.	
" " " $\text{Є}_{13}\text{H}_{28}$,	Є 84·78 H 15·22
	100·00

In estimating an analysis, I consider that the determination of carbon is, as a rule, quite liable to be slightly deficient; and that, on the other hand, the hydrogen is likely to be in excess. Viewing my analyses of the members of the 3d series in this light, especially with reference to the hydrogen, I think no chemist would doubt that these bodies belong to the $\text{€}_n H_{2n}$ series, and not to the series of hydrids, to which they have been assigned by Pelouze and Cahours. We must of course depend on the results of analyses to settle this question. Then to determine the probable formula of a body of this class, its position in the series, we rely mainly on the vapor density.

I have adopted for the body boiling at 216° the formula $\text{€}_{12}H_{24}$, although the vapor density found is 0·352 above the theoretical number, agreeing more nearly with that of the next higher member of the series. Prominent among the reasons that induced me to give preference to the formula adopted, is the fact that, with this formula the discrepancy is in the right direction, while with the higher formula it would be quite the reverse; it being generally the case, especially with bodies of high boiling point, that the theoretical vapor density is below that found by experiment.

Pelouze and Cahours gave to their body boiling at 216°–218°, the formula $\text{€}_{13}H_{28}$, the theoretical vapor density of which, by my calculation, is 6·365; their determination of the same was 6·569.

I would simply add, that it is my intention to present to the Academy at its next meeting, the long delayed article, which will contain full details of the analyses and vapor densities of all the hydrocarbons that I have separated from Pennsylvania petroleum, and I will send the article soon after, for insertion in the American Journal of Science.

II. MINERALOGY AND GEOLOGY.

1. *The Carboniferous age of a portion of the Gold-bearing Rocks of California;* by William P. Blake.—In a former No. of this Journal[*] Prof. W. H. Brewer, in noticing the reports of the Geological Survey of California, observes as follows: "We are now led naturally to consider the question of the age of the rocks of the auriferous series in California. They have been regarded as older than the Carboniferous by all writers on the subject, previous to the publication of the Reports under consideration. The announcement, therefore, of their later age has created unusual interest among geologists." Further on page 364, he cites the following statement from Prof. Whitney;[†] "We have not a particle of evidence to sustain the theory which has so often been brought forward that all, or even a portion, of the auriferous rocks are older than the Carboniferous,—not a trace of any Silurian or Devonian fossil ever having been discovered in California or indeed anywhere to the west of the 116th meridian."

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[*] Volume xli, No. 123, May, 1866, p. 361.

[†] *Report* of the Geological Survey of California, vol. i, Paleontology, Preface.

These statements, in connection with others made by Prof. Brewer,* are to the effect that prior to the labors of the Geological Survey of California the gold-bearing rocks of that State were regarded as older than the Carboniferous (i. e. Devonian or Silurian) by those who had previously made geological explorations in the State, or had published upon the subject, and that it was reserved for the Geological Survey to show that the gold-bearing rocks were not of those older periods. This is an error, inasmuch as the writer of the present notice had several years before distinctly published his opinion that a considerable portion of the gold-bearing rocks of California were of the age of the Carboniferous, and had given reasons therefor. This opinion was coupled, also, with expressions of doubt of the existence of Devonian and Silurian formations in the gold-region, although the possibility of their presence was admitted. These assertions are sustained by the following quotations:

"It is probable that the beds of limestone observed in the gold region and in the passes of Sierra Nevada are of the age of the Carboniferous, and that a considerable part of the auriferous slates are of the same system. A recent examination of the rocks of New Mexico leads me to regard this as more than probable. It is also probable that a great part of the rock formation of the gold region will ultimately be found to be Devonian and Silurian, though as yet there is no evidence on this point except the similarity in their lithological characters to the auriferous rocks of the Atlantic slope."† Again, in the body of the same work in a summary of the principal geological features of the central portion of the gold region it is written (p. 276): "The next important formation is the white crystalline limestone which was found developed to such an extent at Columbia, Sonora, Cave City and the vicinity.‡ It attains a great width, is nearly vertical in its planes of structure, and appears to form a long belt trending northwesterly through Tuolumne and Calaveras counties. It probably extends much farther both north and south. It is believed to be parallel to and conformable with the great slate formation. At Abbey's ferry on the Stanislaus it was found in connection with mica-slate and granite. This rock is doubtless metamorphic, but as no fossils have been found in it, it is impossible to decide upon the period to which it should be referred. It is possibly *Carboniferous limestone*, this formation having been recognized in the northern part of the State, while we are yet without evidence of the presence of Silurian formations west of the great central chain of mountains."

The carboniferous rocks referred to in the northern part of the State were those recognized by Dr. J. B. Trask, and noticed in his Report of 1855. These were not perhaps identified as gold-bearing. In the geological Report by Dr. Newberry the possibility of the gold region being Carboniferous is mentioned. He says: "from its relations to the limestone discovered by Dr. Trask near the base of Mt. Shasta, and which is of Carboniferous age, one may suspect it to belong to that era."* On p. 29 he observes: "If, as seems probable, the fossiliferous limestones of the mountains connected with Mt. Shasta shall prove to be continuous with the limestones of the Sierra Nevada referred to above, they will perhaps serve as a key by which to unlock the whole structure and age of the great Californian range."

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* "On the age of the gold-bearing rocks of the Pacific Coast." This Journ., xlii, July, 1866.

† Report of a Geological Reconnoissance in California. 4to, 1858. Preface, p. iv. (Author's edition of the Geological Report in vol. v, of U. S. Explorations and Surveys)

‡ [*This limestone is traversed in places by quartz veins bearing gold.*]

In a descriptive notice by the writer of the gold veins and deposits of New Mexico, the following observation occurs: "It is remarkable that in one place at least, gold occurs in strata of quartzose sandstone probably of the age of the Carboniferous, and in great ferruginous beds rather than in veins."†

At the time the foregoing observations were made, it was the commonly accepted opinion that gold bearing rocks in general and especially in North America were of Silurian age. To venture to refer any portion of the California formations to a period more recent, and as late as the Carboniferous, was a bold step in advance, and if it was not initiative, it is at least one of the links in the chain of evidence which has led to the conclusion that gold cannot be regarded as characteristic of the rocks of any particular geological epoch and that it may be found in formations of any period where the conditions are favorable.

If in opposition to the evidence which has been presented, it is objected that there was no demonstration of the age of the rocks by fossils, or by tracing continuity, from known rocks; or further that it was merely stated as "probable," or "more than probable," it may be said in reply that as regards the portion of the gold-belt under consideration it is yet a matter of opinion, not of demonstration. The discovery of other localities of Carboniferous fossils in the northern part of the state, at Bass Rancho and Genesee valley has afforded additional evidence, and yet Mr. Brewer very justly does not positively assert the Carboniferous age of this belt southward, but says "all these limestones are of the same lithological character, and there seems little doubt that all the patches are of the Carboniferous age that lie in nearly a direct line from north of the Klamath river to Tahichipi valley a distance of over 500 miles.‡"

In the article by Prof. Brewer on the age of the gold-bearing rocks of the Pacific coast,§ he controverts the writer's statement that the Silurian age of the gold rocks of California has not always been assumed, by partially citing paragraphs from my Report. One of these paragraphs, it is said, "paves the way for priority of discovery should they [the rocks] actually prove to be Silurian by tating that the conclusions arrived at by Sir R. I. Murchison were onfirmed by his (Prof. Blake's) observations in California."

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* Pacific Railroad Reports, vol. vi, p. 22.
† Proceedings Boston Soc. N. H., vii, July, 1859, p. 66.
‡ This Journal, xli, May, 1866, p. 362.
§ Ibid, xlii, July, 1866, p. 116.

This is a serious imputation, but is, however, without foundation as will be seen by reference to the passage indicated by Prof. Brewer. This passage does not refer in any way to the age of he gold-bearing rocks, but relates solely to the date of their impregnation with gold and to the detrital deposits as connected with it. Moreover the paragraph does not state that the "conclusions," as Prof. Brewer says, but that the *conclusion* was sustained, and this single conclusion is given in full, so that there is no possibility of mistaking which one of Sir R. I. Murchison's conclusions was intended by me. The following is the paragraph.[*]

"All the observations upon the auriferous deposits sustain the conclusion arrived at by Sir Roderick I. Murchison, after his explorations in the Urals, that the formation of gold is, geologically speaking very modern; that it is one of the most recently formed metals; the rocks being probably impregnated with it after the Miocene period, and but a short time before the epoch when the powerful and general denudations took place which destroyed the large extinct mammalia."[†]

This paragraph follows a description of the various forms of auriferous drift, and no reference whatever is made to the Silurian or Devonian age of the rocks.

The other statement, given in my preface, of the probability of the presence of Silurian formations, when fully quoted, as in the commencement of this article, bears internal evidence of the injustice of this imputation by Prof. Brewer. A full statement of the conditions of the problem required that the possibility of the presence of Silurian rocks should be recognized. It is not possible to affirm with certainty today that they are not represented in the broad metamorphic zone of the Sierra Nevada. The recent discovery of Silurian formations in the silver and gold region of Nevada, east of the Sierra Nevada, and comparatively near the latter, renders this question more interesting.

There are other statements and criticisms in the articles by Prof. Brewer, to which the writer takes exception, but without reply, as it is not the purpose of this article to discuss claims of priority upon any other point than the opinion in respect to the Carboniferous age of a part of the gold-bearing rocks.

New Haven, February, 1868.

6. *Memoirs presented to the California Academy of Sciences*, vol. i, part II. "*Principles of the Natural System of Volcanic Rocks*, by F. Baron Richthofen." 95 pp. 4to. San Francisco, 1868.—The author classifies volcanic rocks in the following orders and families.

Order first: Rhyolite; fam. 1, *Nevadite;* 2, *Liparite;* 3, *Rhyolite proper.*

Order second: Trachyte; fam. 1, *Sanidin trachyte;* 2, *Oligoclase trachyte.*

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[*] *Report Geological Reconnoissance in California*, pp. 218–9.

[†] Siluria.

Order third: PROPYLITE; fam. 1, *Quartzose propylite;* 2, *Hornblendic propylite;* 3, *Augitic propylite.*

Order fourth: ANDESITE; fam. 1, *Hornblendic andesite;* 2, *Augitic andesite.*

Order fifth: BASALT; fam. 1, *Dolerite;* 2, *Basalt;* 3, *Leucitophyre.*

The late date at which this paper is received, prevents any extended notice. The author shows that he is familiar with his subject through extended observations of rocks in place, and his memoir is an important contribution to this department of Geology. Some of the theories adverted to are at variance with views held by some eminent geologists, but the well known scientific character of the author, the value of his labors in a similar field before, and the amount of field observation and experience which he brings forward to support the conclusions arrived at, give them an especial weight and value. W. H. B.

3. *Report on the Geology of Nebraska.*—The final report of the Geological Survey of Nebraska, is already in an advanced stage of preparation. Mr. Meek, the Paleontologist, has already figured and described over 100 species of Upper Carboniferous fossils, making in all 11 plates of the sizes of those in the report of the California Survey. There are over 350 figures, some of which are European, to afford means of comparison of the American forms with those identified by Geinitz and others with European types. The whole work has been done in that careful, exhaustive manner, which characterizes all of Mr. Meek's labors. Twelve plates of fossil plants, Cretaceous and Tertiary, will accompany the report. There will also be a map and full illustrations.

The preliminary report of Hayden, written in the field, is printed in the annual report of the Commissioner of the Land Office, and will soon be distributed. It comprises nearly 60 pages, and treats quite fully of the geological, agricultural, and economical resources of the State, and calls the special attention of the people to the importance of cultivating forest trees. It is very desirable that these surveys should be continued until every territory west of the Mississippi is carefully examined and reported upon.

4. *Documents sur les Tremblements de Terre et les phenomènes Volcaniques des Isles Aleutiennes, de la Peninsule d'Aljaska, et de la Côte N. O., d'Amérique;* par M. ALEXIS PERREY. 132 pp 12mo.—Prof. Perrey of Dijon published in the years 1863 and 1864, memoirs on the earthquake phenomena of the islands of the western and northern Pacific ocean and Northwest America; and here he returns, in his memoir of the above title, to the subject of the Aleutian Islands and Alaska, regions in which this country has now a special interest. With his usual thoroughness and energy, he has cited facts from a large number of works, and some that are accessible to but very few readers.

5. *Note sur les Tremblements de Terre en* 1863 *avec suppléments pour les années antérieures de* 1843 *à* 1862; par M. ALEXIS PERREY. *214 pp.* 12mo. Présentée à l'Académie royale de Belgique, le 4

1865.—This extended memoir of Prof. Perrey contains a ;ue of the earthquakes over the globe of 1863 as far as any ts of them have been published, with details where they be obtained; and also additions to his former notes on the uakes of previous years back to 1843. These successive re- on earthquakes and volcanoes by Prof. Perrey are the result ast amount of labor, and are of great value to geological e.

III. BOTANY AND ZOOLOGY.

iocene Flora of the Polar Regions.—We have heard much of the extensive collections of fossil plants from various f the arctic regions, which have recently been studied by eer. We have not seen his Flore Fossile de Régions Polaires, article in the Bibliothèque Universelle, translated for nals and Magazine of Natural History, gives an interesting ry of the striking results.

arctic fossil flora counts 162 known species, of which 18 are gamic, 9 of them Ferns of large size. There are 31 Co- 14 Monocotyledons, and 99 Dicotyledons proper. Seventy- f these are supposed to be trees, and fifty shrubs, making neous species out of 162. The fossil Coniferæ of Greenland, l, and Spitzbergen, no less than of Arctic America, mostly re- existing North American species. There is a Spruce very related to our White Spruce, now one of our most north- es. *Sequoia* or Redwood, now represented in California only, species, had four species in the Miocene polar beds, three of occur at the same level in Central Europe. One of these the most abundant tree of northern Greenland, but of wide ver both continents, is very nearly allied to the true Red- *S. sempervirens.* Another, abundant in Iceland, is as near *igantea.* A third, from Greenland, is intermediate between wo. The bearing of facts like these is obvious, as also that discovery of a fossil *Salisburia* in Greenland, the extant spe- ing from Japan. The Cypress family is represented by *ium* and the allied *Glyptrostrobus*, also by *Thujopris*, all panese and North American. There were Chestnuts and at species of Oak in Greenland; one of them has been traced hern Canada, and is the analogue of our *Quercus Prinus.* enland also a Walnut, a Magnolia, with coriaceous leaves, Plum; in Spitzbergen a Lime-tree (*Tilia*); in Iceland a and a Tulip tree! An Ivy has been found on the shores of ckenzie river, two vines in Greenland, and one in Iceland; ee approaching certain United States species. There were n these now icy regions, forests of various deciduous or ever- broad-leaved trees, as well as Coniferæ of various forms, and ivy entwined these with their branches, and beneath hade grew numerous shrubs and elegant Ferns." A. G.

es Fleurs de Pleine Terre. 2eme édition, 1866. *Atlas des de Pleine Terre*, etc.; par Vilmorin-Andrieux & Cie. Paris, 1867.—The first edition of this choice little work was noticed at the time of its appearance. This second edition is considerably enlarged, one fifth being added to the length of the page, and the pages increased to nearly 1300. It enumerates and briefly describes, in popular language, but in a good degree scientifically, the principal hardy herbaceous plants in ornamental cultivation in France, and gives details as to their management and propagation, specifying their varieties, often with considerable fulness. To this work, the *Atlas*, now issued, is an invaluable addition. It is printed in a page of the same size, so that the two may be bound together, as two volumes,—the second part, beginning with p. 1009, going with the Atlas. This second part treats of the application of the plants, described in the first part, to the decoration of gardens, grounds, and dwellings; gives lists under various heads of those most desirable for different situations and circumstances, e. g., selections of Grasses, of sweet-scented flowers, of those ornamental in fruit, of hardy Ferns, with directions for a fernery, of rock-work plants, of aquatics, of plants which will grow well in shade, of picturesque plants, whether for blossoms or foliage, of conservatory or tender plants proper to be turned out for ornamentation of grounds in summer, of plants for ribbon-border or for masses of color; a calendar of the flowers of each month; and finally plans of gardens, parterres, and other ornamental grounds, with the plants to use; classes of border-flowers, &c., according to their colors; and a dictionary of terms, and a list of principal synonyms in English, German, Italian, Spanish, &c. Altogether the book if translated into English, even without special adaptation to our own climate or needs, would really be worth more, in our opinion, than all the gardening books we have put together. One like it would be needed, however, for trees and shrubs. But, returning to the Atlas. This has 1128 extremely neat wood engravings of as many plants, mostly 6 upon a page or plate, the page opposite the figures containing the explanations. The figures to be sure are miniatures, each compartment being only two inches high, and look more natural through the botanist's lens than under the naked eye; but they bear magnifying, as only well executed work would, and they are so chosen as to illustrate a very great variety of species and families. The work is published by the celebrated seed merchants who edit it, Vilmorin-Andrieux & Cie, of the Quai de la Mégisserie, Paris.

3. *The great Dragon Tree of Orotava*, Teneriffe, the King and Nestor of the Monocotyledons, is no more. A drawing of it made by Mr. Borda, one hundred years ago, was published about 60 years ago by Humboldt, who first drew scientific attention to this vegetable wonder. The late Mr. Webb published, in his history of the Canaries, figures of it taken after the storm of July 21, 1819, had destroyed half its crown; and it has recently been described, measured and photographed by Prof. Piazzi Smyth. He gave the trunk a girth of 48½ ft. at the lowest accessible part, and a height of *60 feet*. Fenzi of Florence, who announces the demise of the tree,

nakes the circumference about 78 English feet, but intimates that e was not able to measure it exactly. When he visited it, a year go, "it was still in excellent health, its immense crown covered ith innumerable panicles of scarlet fruits, and the huge trunk, lthough completely decayed in the interior, sustained vigorously he spreading mass of fleshy branches and sword-like foliage." He harges the destruction of this famous historical monument to the heer carelessness of the Spanish authorities, who might have prevented it by keeping up sufficient props. That venerable trunk was, it is said, as hollow and about as large in the year 1402 as in recent times; and the hollow had even then been used immemorially by the Guanches for religious rites. The age of 6000 years which has been assigned to it by some of the "most sober naturalists" may not be very greatly exaggerated. Probably even the cavity was as ancient as the oldest of California Redwoods. A. G.

4. *Geological and Natural History Survey of North Carolina; Part III. Botany, containing a Catalogue of the Indigenous and Naturalized Plants of the State;* by Rev. M. A. CURTIS, D.D., &c. Raleigh, 1867. pp. 158, 8vo.—An important, neatly printed catalogue. Its greatest interest is in the Cryptogamic part, which occupies considerably more than half of the volume. The Flowering plants enumerated are 1873, the Flowerless 2924, of which 2392 are Fungi, i. e., of the order to which Mr. Curtis has devoted the greater part of his scientific life. Acknowledgments are made to Mr. Sullivant for assistance in arranging the list of *Musci* and *Hepaticæ*, and to Prof. Tuckerman, in that of the *Lichenes*. This assistance, it would appear, was rendered several years ago, as the arrangement does not in all respects represent Prof. Tuckerman's later views. The catalogue is, undoubtedly "much the most extensive local list of plants ever published in North America;" and, from the central position of North Carolina in the line of the Atlantic States, and from its including the most developed portion of the Alleghanies, it is very important to our botanists in the illustration of geographical distribution and range of species.

As regards the *Fungi*, that State may be supposed to contain nearly all the species of the Atlantic States. It is much to be wished that Dr. Curtis would now seriously devote himself to the elaboration of a Manual of the *Fungi* of the United States. Otherwise a vast amount of knowledge of these obscure plants may be one of these days lost to the world, and a great want long remain unsupplied. A. G.

5. *Genera Plantarum*, by BENTHAM and HOOKER.—The third part, completing the first volume of this most important work, and the Polypetalous series, was published late last autumn, and should have been announced before. We expected, however, to have prepared an extended notice of the volume, which we have as yet been unable to do. The work supplies excellently a great want, and will at once be in the hands of all scientific botanists. A. G.

6. *Illustrations of the Genus Carex;* by FRANCIS BOOTT, M.D. Part IV, Tab. 412–600. 1867.—This posthumous volume, issued

by Mrs. Boott as a tribute to the memory of her late husband, has just come to hand, and will be received as a great boon by the lovers of Carex, who still feel the loss of their leader and master. A full notice of the work will find a place in the ensuing number.

A. G.

7. *Botanical Necrology for* 1867, *concluded.*—The following articles were excluded from the last number, for want of room.

Dr. C. H. SCHULTZ (Bipontinus), a distinguished botanist who devoted his attention almost exclusively to *Compositæ*, and has brought together an extremely rich herbarium in that vast family, died at his home in Deidesheim, Rhenish Bavaria, on the 17th of December last, at the age of 62 years. He had brought together a greater amount of the materials requisite for a monograph of the order, than are possessed by any other herbarium; but his publications, although numerous, are mostly in scattered papers.

Dr. CHARLES D. B. DAUBENY, Professor of Botany and Rural Economy in the University of Oxford, Senior Fellow of Magdalen College, died, at Oxford, on the 12th of December last, in the 73d year of his age. He was Professor of Chemistry in the University, from 1822 down to 1855, when upon the reorganization and extension of scientific studies in the University—largely due to his own efforts and influence—he resigned that chair to the present incumbent. He was appointed Professor of Botany in 1834, and Professor of Rural Economy in 1840, when by the completion of the publication of the *Flora Græca* Sibthorp's endowment became available.

As chemist, geologist, one of the founders of the British Association, and an active promoter of natural and physical science in various departments, Dr. Daubeny deserves a more comprehensive memorial than can here be attempted. In botany his contributions are in the line of vegetable physiology and of classical learning. His first paper upon such subjects (but some years later than his volume upon volcanoes, issued in 1826), "On the degree of Selection exercised by the Roots of Plants," probably brought forward his name for the Botanical professorship, almost a sinecure at the time, and to which, when it fell vacant, the University authorities, as we have been told, were about to prefer some "worthy" person who was wholly ignorant of natural science. But the College of Physicians in London, which shared the patronage, insisted upon a scientific if not a botanical incumbent, and so secured the appointment of Dr. Daubeny. To qualify himself for this position he became a pupil of DeCandolle, and afterward of Lindley; and in 1836 he justified the appointment by publishing, in the Philosophical Transactions, his Essay upon the action of light upon plants and of plants on the atmosphere. He here established the capital fact that the luminous rays (and not the chemical or actinic, as has quite lately been assumed by prominent physicists) of the solar spectrum are those chiefly efficient in the evolution of oxygen gas from the green parts of plants, and therefore in assimilation. This has been followed by many other papers or lectures upon similar subjects, mainly upon the applications of vegetable physiology and chemistry to agriculture, but none of such scientific importance as this. In 1857 he published his Lectures on Roman Husbandry, treating also of the Horticulture of ancient times, and concluding with notices of the plants mentioned in Columella and Virgil. In 1865 he published the substance of another course of lectures in a volume entitled, Essay on the Trees and Shrubs of the Ancients,—a work which was noticed at the time in this Journal. Dr. Daubeny did not pretend to be a practical botanist; but in his biographical notice of his preceptor DeCandolle, he shows that he had well mastered the principles of the natural system. The neat Botanical Garden at Oxford owes much to his liberality as well as his care; and a little subsidiary experimental garden, excellently planned, has been entirely supported by the resources of the venerable and much respected late Professor. Dr. Daubeny visited the United States in 1837 or 1838, travelled widely over the country, and printed for private circulation a brief account of his observations. His chair will be filled, we trust, by a better, because a special, botanist, but it hardly can be by a more excellent man.

A. G.

7. "*Memoirs presented to the California Academy of Sciences*, vol. i, part I. *A Catalogue of the species of Mosses found up to the present time, on the northwest coast of the United States, and especially in California;* by LEO LESQUEREUX." 38 pp. 4to. San Francisco, 1868.—As the title indicates, this is a mere Catalogue; but it contains descriptions of quite a number of new species. The enumeration comprises 265 species, 215 of which are from California. The most of these have been collected by Mr. Bolander, of the Geological Survey, and upward of 90 species have thus far been found by him only. All the earlier botanists in California noticed the exceeding paucity of mosses in that part of the continent, and some of the most skillful collectors have declared that mosses are almost absent from the flora; only about 50 species having been found within the state before the geological survey began its labors in 1860. Mr. Bolander alone has since collected nearly 200 species, and he believes that when the region shall have been as fully explored as are similar regions in the eastern States and Europe, that the Pacific States will be not less rich than they in species of this order. It is an interesting illustration of how much may be done by one man to correct the errors of too hasty generalization.

8. *A Botanical Semi-centennial.*—On the 20th of December last a supper was given at the Astor House to Dr. John Torrey by the Botanical Club of New York, it being just fifty years since he presented to the Lyceum of Natural History of New York his "*Catalogue of Plants growing spontaneously within thirty miles of New York City.*" Besides the members of the Club, there were present by invitation, Prof. Gray, Col. Olney, Prof. Brewer, Prof. Eaton, Dr. Pickering, Mr. Thos. P. James, Drs. Green and Porter of Easton, Pa.,

Mr. Parsons of Flushing, Mr. Buchanan of Astoria, and Mr. C. F. Austin of Closter, N. J. Letters were read from many prominent Botanists regretting their inability to come.

After the supper, Prof. Thurber called the meeting to order, and proposing the health of Dr. Torrey, gave a detailed account of his botanical labors. Dr. Torrey followed, first acknowledging his appreciation of the unexpected compliment of this supper in his honor, and then telling of the great difficulties he formerly encountered in the prosecution of Botanical Science. Prof. Gray, Prof. Eaton, Dr. Pickering, Prof. Brewer, Mr. Wm. Leggett and Mr. James Hogg responded to the other regular toasts of the evening, after which other gentlemen were called upon for speeches. Mr. James produced the manuscript-journal of Frederick Pursh, made during his American travels. This journal has lately been discovered in the library of the Philadelphia Academy, and proves to be of such interest that its publication by the Academy is greatly to be desired. Prof. Gray remarked that he had rescued from oblivion also, the hand-drawn map which belonged to the journal. Among other points of interest, it may be noted that this journal describes the exact place where Pursh discovered the Scolopendrium.

The occasion was one of great interest to those who were present, and all who spoke testified to the great kindness with which Dr. Torrey had always aided their botanical efforts. May the spirit shown by this eminent man be cherished by all who shall follow in the path he has opened to American botanists.

IV. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Die trockene Distillation des Holzes und Verarbeitung der durch dieselbe erhaltenen Rohproducte auf feinere.* Ein Handbuch für Techniker, Chemiker, und Fabrikanten. Nach eigenen mehrjährigen Erfahrungen bearbeitet von Dr. Eduard Assmuss. Berlin, 1867. 8vo, pp. 144.—Among the often wasted products that are capable of being turned to good account, none is more worthy of attention than wood smoke; especially in a country in which a heavy excise duty on spiritous liquors almost amounts to a prohibition of the manufacture of the acetates by means of the oxydation of alcohol. But if the charcoal-burner has desired information respecting the utilization of the condensible vapors, he has hitherto been obliged to put up with the meager and ill-digested accounts scattered in books of general chemical technology; for the work before us is the only one that has ever been published, specially devoted to the subject of which it treats. The author having been chemist and superintendent of a manufactory in Western Russia, of the products obtained by the destructive distillation of wood, should be well fitted for bringing together all that is known respecting the matter in hand. He aims to give a practical treatise and to detail only such methods as his own experience has proved good. He has very wisely avoided the too common absurdity of swelling the size of a mere technical work by useless preliminary chapters

on general chemistry, and, indeed, has confined himself to rather too narrow a range; for much might have been added which would have been altogether pertinent to the subject, and at the same time interesting and profitable to his readers. Greater completeness might have been attained by giving some account of methods and apparatus recommended by others, and by noticing products likely to prove useful in the arts. Thus in treating of the acetates possessing a commercial value, acetate of baryta would seem deserving of mention, since this salt may, in many cases, well replace the more costly acetate of lead, and it can be easily manufactured pure, even from very crude materials.

Re-distilled pyroligneous acid neutralized with witherite or with sulphid of barium and evaporated almost to dryness, with constant stirring, gives a dirty, granulated product which may be purified by washing it with pretty strong alcohol. The alcohol dissolves the gummy and tarry matter and leaves the acetate clean and of a pale brown color. When these brownish crystals are dissolved in water and treated with a little bone black, we obtain by filtration a colorless solution, which, on being dried down affords a nice white salt. So dense is acetate of baryta, that but small quantities of alcohol are required for systematic washings; and it is not unlikely that the alcohol might be replaced by wood spirit. Of course the alcohol may be recovered by distillation, and used again and again.

The manufacturer who would carry on his work intelligently should know how to determine the strength of his products by some way giving more certain indications than the mere hydrometer; and the entire omission of everything relating to this matter seems to us a defect in the book before us. A ready mode of testing pyroligneous acid is a desideratum, for the acid itself assumes a very deep color when neutralized, and the common acidimetric method depending on the change of litmus, is therefore precluded. Litmus is at best but an indefinite indicator of the neutralization of acetic acid. In trying transparent and light colored vinegars it is a good plan to add a few drops of a solution of neutral sulphate of copper and then proceed with the addition of a normal alkali. The least excess of alkali gives rise to a perceptible opacity in the liquid under examination. But pyroligneous acid becomes impervious to light so that even this artifice is unavailable. Perhaps the easiest course would be to ascertain with a delicate hydrometer, the increase of specific gravity caused by digesting the acid for some time with an excess of pure dry carbonate of lime, carbonate of baryta, or oxyd of zinc, tables having been constructed according to exact analyses, to show the percentages of acid corresponding to every increase of density. But no testing whatever should be entrusted to a mere practical man, until he has been specially instructed in the proper routine by some one well skilled in chemical manipulation. We were forcibly impressed with this thought by an instance that came under our notice a few years ago. A vinegar maker having sold a large quantity of his vinegar, warranted to be of such strength that each fluid ounce should require for its neutralization fifty grains of carbonate of potash, was surprised to be told that it was found to fall far short of the guarantee. Not satisfied with the report of a professed chemist, he went to the storehouse of the buyer to prove that he himself was right, and took his carbonate of potash with him. Getting an average from many barrels, he measured out a fluid ounce. Then weighing fifty grains of the carbonate, he added it little by little, to the *cold* vinegar till the effervescent solution turned litmus paper blue, and had two grains left. The chemist repeated the experiment, heating the vinegar, of course, and showed him that by proper manipulation only twenty-nine grains of carbonate were required. Moreover, the carbonate was in suspiciously large crystals and turned out to be pure bicarbonate, twenty-nine grains of which would be equivalent to but twenty-five grains of the crystallized carbonate. This manufacturer is not the only one who has for years rested satisfied with cold testing by something supposed to be carbonate of potash, but really of unknown strength.

The author gives a pretty full description of the wrought iron retorts which he himself has used in charring wood; but in size and general arrangement they do not seem to us to be specially worthy of imitation. He also describes a judicious modification of Reichenbach's kiln, which he prefers for operating on the largest scale, because, as he says, the horizontal iron retorts soon burn out, and they allow but small quantities of wood to be distilled at once. The first cost of iron is great, especially in regions where wood is cheap, and those who have wood in abundance and wish to carry on a large business, would do well to try something like the kiln which he recommends. Rectangular and circular kilns of brick are most commonly used in this country for the simple charring of wood, but not when the acid is the chief object of the operation. Our makers of pyroligneous acid distil wood in iron retorts, and some even so far blindly copy what they have seen that they very absurdly have the cylinders six feet long, though the wood is brought in lengths of four feet and consequently a part has to be sawed in two to fill out the odd two feet. Others show more judgment in regard to size, and after trying various forms, consider it most advantageous to have cylinders cast in flanged quarters and bolted together. But retorts to be heated merely by an external fire cannot well be more than four feet in diameter, and are seldom made so large, so that it takes a great number to do much work. Some of our gunpowder manufacturers char their wood in an apparatus which in some measure combines the advantages of the kiln with those of the older form of retort. It consists of a cylinder whose sides are made of quarter-inch boiler plate and riveted to heads of cast iron. Through the lower part, about eight inches from the bottom, runs horizontally a very thick cast iron flue consisting of a fire-place one foot in diameter, and four feet long, bolted to the front head, and an extension six inches in diameter slipping loosely through a hole in the back head. There is a hole in the front head corresponding to the diameter of the fire-place and closed by a door swung on hinges. To a hole in the upper part of the back head is attached a pipe six inches in diameter for carrying the vapors to the condenser. In the upper part of the front head is a hole about three feet square, for charging and discharging, which is closed by a flat cast iron door hung on hinges and held tight by a cross bar and wedges. The retort is so set in brick work, that when the flame from the wood burned in the fire-place has passed through the extension to the back end, it turns and wraps around the cylinder and passes into a chimney over the front end. The two pipes constituting the fire-place and its extension, have to be renewed every year or two, but the cylinder will last many years. As the charging door must necessarily be over the fire-place, these retorts are very inconvenient to discharge, and are not even easily charged. But the difficulty may be remedied by making the retort of greater diameter so as to give room for two internal flues instead of one. In an improved form the cylinder is made seven feet in diameter and thirteen feet long, with cast iron heads nearly two inches thick. In the central part of the front head is an opening extending from top to bottom and of such width as to allow a man to walk in and carry the wood for charging. In the lower part, on each side of this doorway, is a hole thirteen inches in diameter forming the entrance to the fire-place, which is a thick iron pipe a little over four feet long, or long enough to take in a common stick of wood. These fire-place apertures are furnished with hinged and latched cast iron doors. The charging aperture has a door not simply flat, but with returned edges like a shallow trunk lid. These returned edges add greatly to the strength and stiffness of the door and prevent it from warping in the casting or while in use. The door is hung on very stout hinges, and during the distillation it is kept closed by three cross-bars with set screws From each fire-place pipe, a cast iron flue eight inches in diameter extends just through the back head of the retort, and this slip-joint is kept tight by luting with clay or mortar. Only the lower part of the back head is exposed to the flame from the fire, the retort being set so that the flame turns, after leaving the internal flue, and passes forward under the lower half of the cylinder, then up and backward around the upper half to a chimney at one of the back corners of the brick work. To a hole twelve inches in diameter in the back head is attached a cast iron pipe which carries the volatile products of the distillation to a suitable condenser. Such a retort holds nearly three cords of wood and is quite as easily worked as a one-cord cylinder. The distillation occupies thirty-six hours and requires about one cord of wood for fuel, a quantity proportionally somewhat less than that consumed in heating the smaller retorts.

In the second division of the work, the author gives plain and concise directions for preparing dry acetate of lime, other acetates having commercial importance, acetic acid, and wood spirit. This book, like all others, throws no light on the interesting problem, *how to purify pyroligneous* acid without the roundabout and expensive process of converting it into acetic acid proper. The only practical answer that we have hitherto been able to obtain is but a partial one. If we distil the acid, treat the product with enough chlorid of lime to oxydize and precipitate the dissolved tar, about a pound of bleaching powder to five gallons of the distillate,—add sufficient muriatic acid to take up the lime, and then redistil,—we obtain an almost colorless vinegar which is pure enough for many uses in the arts, but still retains an unpleasant odor.

Lastly, the book treats of the very few soluble products which may be obtained from the tar, and of the sanitary aspects of the whole business.

Though the work contains little that is really new, and some of the methods given are susceptible of improvement, the manufacturer of progressive disposition will find it well worth reading, and he may get from it some hints which will tend to a bettering of his own plans. J. M. O.

2. *Reclamation by Eug. W. Hilgard.* (From a letter to the editors, dated University of Mississippi, Oxford, January 8, 1868.) —In Budge's Handbook of Physiology, edition 1862, page 940, where the distinction between "savors" and "flavors" is discussed, the entire credit of the discovery and explanation of these facts is given to Dr. Schinner, who in a "Dissertatio," 1856, and in "Deutsche Klinik," 1859, puts forth as new, a portion of what, so long ago as 1849, was demonstrated before a class of fellow students and upon no less a person than that of Prof. Ludwig, then at Zürich, by my brother, Dr. Theod. C. Hilgard (now of St. Louis) and myself; was subsequently made the subject of my brother's inaugural thesis, maintained before the faculty at Würzburg, in 1852; then formed the substance of a paper read before the American Association at the meeting of 1854, and published in that year's proceedings.

These dates suffice to establish priority even as to publication, on my brother's part, which priority would be greatly antecedent had not Prof. Ludwig failed to realize the importance of the experiment to which he himself was subjected, by attributing his failure to perceive the flavor of the garlic placed in his mouth to a benumbing of the gustatory nerves by the pressure of the unrelenting fingers which closed his nostrils spite of his spasmodic efforts to free them, to "nervous consensus," and the like. He therefore neglected the entire subject in his text-books published at the time; but the matter got wind, notwithstanding, so that when my brother spoke of it to Prof. Virchow at Wützburg, three years after, the professor observed that it was not entirely new, it having been heard of *from Zürich.* My brother's experiments on the subject (in most of which I participated, having started them in consequence of a suggestion made to me in 1848, by Prof. M. Temple of Philadelphia) were carried on, and made no secret of, successively at Heidelberg, Zürich and Vienna, which, together with the thesis at Würzburg, and publication as just stated, renders Dr. Schinner's originality a little questionable. Strangest of all, it took thirteen years from the time these important distinctions were established and divulged by Americans to the highest authorities on the subject of Physiology, then recognized on the continent, to make an impression on European physiologists so far as to lead them to put it into a text-book. This is not, surely, the spirit likely to promote the progress of true knowledge, and has too frequently the effect as well as the appearance of a *suppressio veri.*

EUG. W. HILGARD.

University of Mississippi, Jan. 8, 1868.

3. *On the spectra of the meteors of November* 13–14, 1866; by JOHN BROWNING, Esq.—To view the shower I chose the observatory of Mr. H. Barnes, at Upper Holloway. The situation was good, the observatory being built on high ground and so placed that the radiant-point rose in the contrary direction to the lights of London.

I devoted my attention exclusively to attempting to obtain the spectra of as many meteors as possible.

After catching a few spectra in different directions, I at length decided on keeping the direct-vision prism pointed a little to the west of Leo Major, with the axis of the prism parallel to the horizon. The spectra which I saw were those of meteors which started from the radiant-point and passed through the belt of Orion. Of course the number of meteors which came into my field was comparatively limited; but the whole of them travelled in a direction parallel to the axis of the prism, a condition essential in the observation of the spectra.

From the rapid flight of meteors rendering the spectra very difficult to catch, I cannot pretend to speak with confidence of the appearance of the spectra shown by the prism; but I saw a great difference between the spectra; I believe that I saw spectra of the following kinds:—

A. Continuous spectra, or those in which the whole of the colors of the solar spectrum were visible excepting the violet rays.

B. Spectra in which the yellow greatly preponderated, but which in every other respect resembled those above described.

C. Spectra of almost purely homogeneous yellow light, but with a faint continuous spectrum—that is, a faint trace of red on one side and green on the opposite side of the yellow portion of the spectrum.

D. Spectra of purely homogeneous green light; of this kind I only saw two.

I observed through the prism spectra of several trains. The light, which was mostly blue, green, or steel-grey, generally appeared homogeneous; but this may have arisen from the light having been too faint to produce a visible spectrum. Stars below the second or third magnitude, although visible through the prism, fail from this cause to give spectra in which blue and red are perceptible.

It will probably be remarked that I have not spoken of having observed any lines in the spectra. All the nuclei seemed to give continuous spectra which contained the whole of the colors of the spectrum; what I should term the tails, not the trains, of the nuclei presented the appearance I have described. In every instance I remarked that orange-yellow appeared to preponderate over the other colors in the continuous spectra. When a prism only is used, it seems to me impossible that any sharply-defined lines should be shown. Still, from differences in the colors of spectra, some information may, I think, be obtained. As is well known, chemists and mineralogists infer the presence of certain elements in the substance under analysis from the color communicated by the substance to the blowpipe flame. Thus, if the flame become yellow, they suspect the presence of sodium; red, strontium; green, barium or thallium; lavender, potassium. The prism will do more than this; it will show if the flame contains even a faint trace of any other color, while without the prism the faint color would be completely masked by the color which predominates. From the difficulty of catching meteors within such a narrow space, I fear it will be found impossible to use a prism provided with a slit formed by a pair of knife edges so as to define any lines. But I think it may be possible to use a prism in connection with a cylindrical lens. Such an arrangement would be capable of showing well-defined lines if the observed meteors contained any elements which would give bright lines in an ordinary spectroscope.—*Monthly Notices of the Royal Astronomical Society*, Jan. 11, 1867.

4. *National Academy of Sciences.*—At the recent January meeting of the Academy, held in Washington, the following papers were read.

On the practical character of the usual thermometer scales, and a common substitute for them; by A. Guyot.

The use and interpretation of single and double linear associative Algebras; by Benjamin Peirce.

On the existence of a great central zone of fracture of the surface of the globe; by A. Guyot.

A communication respecting the cosmical theory of the November meteors; by A. C. Twining.

The history of a week in the life of a young Salmon; by L. Agassiz.

On the Fauna of the Gulf of Mexico at great depths; by L. Agassiz.

Remarks on the Buffalo of North America; by L. Agassiz.

On the penetration of sound; by Joseph Henry.

Some points in the geological development of the continent between the Rio Grande and Arkansas river; by John L. LeConte.

On a reflector to be used as a signal in geodetic operations; by J. E. Hilgard.

Exploration of the Coast of Alaska; by Geo. Davidson.

Comparison of the iron meter belonging to the American Phil. Soc., and used as the standard measure of the Coast Survey, with the platinum standard meter of the "Conservatoire des Arts et *Métiers*" in Paris, in the summer of 1867; by F. A. P. Barnard.

On observations of the zodiacal light; by Benjamin Peirce.

Notes on a treatise on topographical drawing, by J. Enthoffer; by J. E. Hilgard.

Remarks upon the condition of the skeleton of Mastodon found at Cohoes, N. Y., and its relations to the geology of the surrounding country; by James Hall.

Solution of a particular form of Algebraic equation; by Benj. Peirce.

Note on the velocity of transmission of perceptions and volitions; by B. A. Gould.

5. *On the Miocene Flora of North Greenland;* by Professor Oswald Heer. (Translated by Robert H. Scott.)—Among Prof. Heer's important results is the following. The flora of Atanekerdluk proves, without a doubt, that North Greenland, in the Miocene Epoch, had a climate much warmer than its present one. The difference must be at least 30° F.

He says that the evidence from Greenland gives a final answer to those who objected to the conclusions as to the Miocene climate of Europe drawn by him on a former occasion. It is quite impossible that the trees found at Atanekerdluk could ever have flourished there if the temperature were not far higher than it is at present. This is clear first from many of the species, of which we find the nearest living representatives 10° or even 20° of latitude to the south of the locality in question. Some of the species are quite peculiar, and their relationship to other forms is as yet in doubt. Of these the most important are a *Daphnogene* (D. Kanii), the genus *M'Clintockia*, and a *Zamites*. The Daphnogene had large, thick leathery leaves, and was probably evergreen.

M'Clintockia, a new genus, comprises certain specimens belonging, perhaps, to the family of the Proteaceæ. The *Zamites* is also new. Inasmuch as we know no existing analogues for these plants, we cannot draw accurate conclusions as to the climatal conditions in which they flourished. It is, however, quite certain that they never could have borne a low temperature.

If, now, we look at those species which we may consider as possessing living representatives, we shall find that, on an average, the highest limit attainable by them, even under artificial culture, lies at least 12° to the southward. This, however, does not give a fair view of the circumstances of the case. The trees at Atanekerdluk were not all at the extreme northern limit of their growth. This may have been the case with some of the species; others, however, extended much farther north; for in the Miocene flora of Spitzbergen, lat. 78° N., we find the beach, plane, hazelnut, and some other species identical with those from Greenland. For the opportunity of examining these specimens, I am indebted to Professor Nordenskiöld. At the present time the firs and poplars reach to a latitude 15° above the artificial limit of the plane, and 10° above that of the beach. Accordingly we may conclude that the firs and poplars which we meet at Atanekerdluk and at Bell Sound, *Spitzbergen, must* have reached up to the north pole, in so far forth as there was land there in the Tertiary period. The hills of fossilized wood found by M'Clure and his companions in Banks Land (lat. 74° 27′ N.) are therefore discoveries which should not astonish us; they only confirm the evidence as to the original vegetation of the polar regions which we have derived from other sources.

He then selects *Sequoia Langsdorffii*, the most abundant of the trees at Atanekerdluk, and proceeds to investigate the conclusions as to climate deducible from the fact of its existence in Greenland. *Sequoia sempervirens* Lamb. (Red-wood) is its present representative, and resembles it so closely that we may consider *S. sempervirens* to be the direct descendant of *S. Langsdorffii*. This tree is cultivated in most of the botanical gardens of Europe, and its extreme northern limit may be placed at lat. 53° N. For its existence it requires a summer temperature of 60° F. Its fruit requires a temperature of 65° F. for ripening. The winter temperature must not fall below 31° F., and that of the whole year must be at least 50° F. Accordingly we may consider the isothermal of 50° as its northern limit. This we may then take as the northern temperature of the *Sequoia Langsdorffii*, and 50° F. as the absolute minimum of temperature under which the vegetation of Atanekerdluk could have existed there.

The present annual temperature of the locality is about 20° F. Dove gives the normal temperature of the latitude (70° N.) at 16° F.

Professor Heer concludes his paper as follows:—

I think these facts are convincing and the more so as they are not insulated, but confirmed by the evidence derivable from the Miocene Flora of Iceland, Spitzbergen, and Northern Canada. These conclusions, too, are only links in the grand chain of evidence obtained from the examination of the Miocene Flora of the whole of Europe. They prove to us that we could not by any re-arrangement of the relative positions of land and water produce for the northern hemisphere a climate which would explain the phenomena in a satisfactory manner. We must only admit that we are face to face with a problem, whose solution in all probability must be attempted and, we doubt not, completed by the astronomer.

OBITUARY.

Christian Gottlieb Ferdinand Engel, born at Magdeburg in Prussia on the 8th of March, 1805, died on the 12th of July, 1866, at Tremont near New York. A man of singular beauty and simplicity of character, an artist and a scientist, he well deserves a few words in remembrance of his honorable and useful life. Mr. Engel received his first instruction at a public school in his native city. The stern will of his father compelled him to learn the trade of a carpenter, but he devoted himself without his father's knowledge to the study of mathematical drawing, and at the age of sixteen sent to the Academy of Arts, in Berlin, a work which received the highest prize. Surprised and touched, his father no longer opposed the youth's wishes; he entered the Royal School of Arts in Magdeburg, and at the conclusion of his studies, bore off the most honorable testimonials. He settled at first in Magdeburg as a teacher of drawing, removed thence to Hamburg, where he taught descriptive geometry, and finally went to Berlin, devoting himself with extraordinary industry and success to the work of instruction. His lectures upon geometry and optics soon became popular and were attended by enthusiastic students from all classes in life. In 1835 he prepared the constructions and drawings for Wolff's descriptive geometry, and some years afterward published, in connection with Prof. Schellbach, two volumes of descriptive optics, to which Prof. Schellbach contributed the text and Mr. Engel the drawings. The work is one of extraordinary beauty and value, but is, we believe, but little known in this country. Mr. Engel's optical studies soon led him to the wave theory of light; he first drew and then executed in wood a model of the wave surface in biaxial crystals. Of these models Prof. Plücker in Bonn received the first; the second was sent to the great Exhibition in London, where Mr. Engel received a prize medal. He afterward published axonometrical projections of the most important geometrical surfaces and sheets of copies for descriptive geometry.

In 1848 the Revolution broke out in Germany, and Engel embraced the liberal side with all the enthusiam of his nature. How sadly the hopes and aspirations of the German liberals were defeated, we all know. Disappointed, disheartened, and persecuted in the political reaction which followed, Mr. Engel sought a more congenial home in this country. For nearly eighteen months after his arrival misfortune seemed to pursue him; his scanty savings rapidly wasted, no means of support offered themselves, and he had formed the resolution to go to England when he made the acquaintance of a few men of scientific tastes and pursuits who appreciated the beauty of his work, and who could not but admire his simple, modest, unobtrusive character. He now found occupation in making optical models of various kinds in wood and plaster. Of these perhaps the most beautiful are the model of the wave-surfaces in biaxial crystals and a wooden model exhibiting the passage of a plane through all the varieties of elliptic to circular vibrations and back again to a plane vibration at right angles to the first. The attention of the late Prof. Bache having been directed to Mr. Engel's drawings and models, the latter received an invitation to enter the service of the Coast Survey. In 1856 he undertook the drawing of the instruments and apparatus of the survey for the great work which Prof. Bache had projected, and even engraved the outlines on copper with his own hand. During the last years of his life he was occupied privately with the projection of curves of equal illumination, hoping in this manner to place topographical drawing upon a scientific basis.*

Science in our country has met with a real loss by the death of Mr. Engel. He possessed in a higher degree than any person whom we have ever known, a true geometrical sense. He solved difficult problems with the greatest readiness by construction alone, and his models are marvels of beauty and precision of workmanship. His skill with the drawing pen was unequalled, and it would be difficult to find anything more beautiful in their kind than his drawings of caustic curves, in the work above referred to, and some unpublished optical sketches which we have had the privilege of seeing. W. G.

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* Mr. Engel left a large collection of optical and geometrical models which are *now on sale for the benefit of his* widow, and which may be seen at 9 Lafayette *Place, New York.*

Sir DAVID BREWSTER, K. H.—Sir David Brewster died at the age of 86 on the 10th of February last.

V. MISCELLANEOUS BIBLIOGRAPHY.

1. *The American Ephemeris and Nautical Almanac for the year* 1869. Published by authority of the Secretary of the Navy. Bureau of Navigation, Washington, 1867. Large 8vo, pp. 516, with Appendix, pp. 40.—This is the 15th annual issue of the American Ephemeris and Nautical Almanac, the first volume having been that for the year 1855. The first 248 pages forms the Nautical Almanac, and is intended for the use of Navigators. It is for that object computed in Greenwich time. The remaining portion is Astronomical, and is constructed for Washington time.

It is the province of such a work to predict astronomical phenomena, especially to give those predictions that supply the practical necessities of navigators, exploring expeditions, boundary commissions, coast and lake surveying parties, and astronomical observers generally.

The necessity of such publications, and the propriety of their issue by government, is evident from the simple fact, that almost all civilized nations issue them annually, even though their commerce, their geographical explorations and surveys, and their astronomical establishments, in most cases, bear no comparison in extent with those of our country.

The oldest series is the *Connaissance des Temps*, published by the *Bureau des Longitudes* of the French Government. This was first issued in 1679, so that the volume for 1869 is the 191st of the series. The *Nautical Almanac and Astronomical Ephemeris* published by the Lords Commissioners of the Admiralty of England, was begun in 1767, the volume for 1871 making the 105th of the series. Ninety-four volumes of the *Berliner Astronomisches Jahrbuch*, more than ninety volumes of the *Effemeridi Astronomichi*, of Milan, more than fifty of the Russian Nautical Almanac, as well as the several series from Vienna, Coimbra, Lisbon, Madrid, Rio Janeiro, and other places, show either that the necessity for such a publication has been felt among all the nations thus represented, or else that it was considered a discredit to a country to be dependent for a nautical almanac upon a foreign government.

Unquestionably at the present day the best known and most important of these Ephemerides are the British *Nautical Almanac*, the *Berliner Jahrbuch*, the *Connaissance des Temps*, and the *American Ephemeris*. Those of Milan and Coimbra have an excellent reputation, but can hardly be placed in the first rank. In the form of the tables the excellent arrangement of the British Almanac, devised in 1830 by a committee of the Royal Astronomical Society, has been most wisely followed by the American Ephemeris. Changes from a system so well known in our marine, ought not to be made without great reason. Yet in the details there are considerable differences. The tables employed are generally different. For the Sun the Nautical Almanac uses LeVerrier's, the American Ephemeris, Hansen and Olufsen's. For the Moon they use severally Hansen's and Peirce's. For Mercury, Venus and Mars, the former employ LeVerrier's tables, for Jupiter, Saturn and Uranus, those of Bouvard, and for Neptune those of Kowalski. In the American Ephemeris, Winlock's tables of Mercury, Lindenau's tables of Venus and Mars (with corrections by Airy, Breen and LeVerrier), Bouvard's of Jupiter, Saturn and Uranus, (with corrections) are used. For Neptune, Peirce's theory and Walker's orbit are adopted. In the Appendix, is an Ephemeris upon the later orbit of Newcomb. To the usual Ephemeris of the planets, is added a table of the rectangular coördinates, of use in computing perturbations.

In the places of the fixed stars there are still greater differences. The apparent places for the upper transit for every ten days are given in the American Ephemeris for 198 stars, in the Nautical Almanac for 147, in the Connaissance des Temps for 116, and in the Berliner Jahrbuch for 72 stars. Hardly any portion of the Almanac is more useful to the practical astronomer, whether on an exploring expedition, on a surveying party, or in a fixed observatory. In another point the American Ephemeris surpasses all the others, namely, in the materials for computing occultations. There is in this a special appropriateness, as there are so many parties in all portions of our wide country, who need to observe these occultations to determine the longitudes of their stations.

The volume for 1869 has been prepared under the direction of Prof. J. H. C. Coffin, those of the years immediately preceding by Prof. J. Winlock, now of the Cambridge Observatory. Only an astronomer can direct such a work, and secure that accuracy without which it is worse than useless, and we trust that the post of superintendent will never be regarded as one to be conferred in routine upon officers who are not astronomers.

We learn with regret that the Committee on Appropriations of the House of Representatives has felt it necessary to reduce the small amount estimated for the Ephemeris, by nearly one-half. We cannot believe that a permanent reduction of the size or character of the Almanac is intended. Too many material interests are concerned, and the credit of the country is too deeply involved. But if the diminution of the appropriation is not to be permanent, it is very unfortunate that it is to be made at all. The volumes should be issued two or three years in advance, and to accomplish this the appropriations must be regular. Under its past and present able direction the almanac is such, as to compare favorably with any similar publication in the world. But irregular or inadequate *support will surely prevent* its maintaining a character creditable to a country with such large maritime interests, such a territory to survey, and we may add, one that is so honorably known for its astronomical science.

2. *Sound: A course of eight lectures, &c.;* by JOHN TYNDALL, LL.D., F.R.S., &c. &c. London. Longman, Greens & Co. 1867.—This work on sound by Dr. Tyndall, is a popular exposition of the leading phenomena of sound and especially of what may be termed *Opt-acoustics.* It is a stenographic report of eight lectures delivered at the Royal Institution. Such books have nearly the life and freshness of the spoken lectures, while they have this advantage over the latter, that the experiments never miscarry, and that all who are addressed have an equal opportunity of seeing and hearing.

The general public has heretofore been compelled to rely for its knowledge of science too largely upon the productions of third, fourth or *n*th rate men, who often furnish rhetoric (falsely so-called) for truth and fancy for fact. This necessity is fast disappearing. By this volume and by his previous one upon heat, Dr. Tyndall has set an example of condescension to the wants of the age, worthy of imitation by others of our masters in science. Dr. Tyndall has indeed rare gifts for a popular teacher. Philosopher, orator and poet (for he has written much poetry, though no verse), his lectures are at once exact, clear and beautiful. As a specimen of his power of lucid exposition, we cite his account of LaPlace's mode of reconciling the observed and calculated velocities of sound in air (pp. 30–32). As one among many instances of a command of felicitous expression scarcely ever seen outside of poetry, we refer to his description of Wheatstone's telephonic concert, (p. 81).

In his lectures on heat, the author appeared more prominently as a *discoverer.* In the present work, original labors are not wanting, but he is mainly an expositor of the researches of others, and most conspicuously of Helmholz.

The true source of "timbre" in musical sounds, the composition of vowel sounds and the origin of resultant tones, as given in the remarkable work* of the latter philosopher, are here satisfactorily presented. We miss, however, with some surprise, even in a popular account of Helmholz's discoveries, what is perhaps the most significant and the least anticipated of them all; namely, that the timbre of a musical sound is independent of the difference of phase under which its constituents are united. Before Helmholz, men had attributed timbre to the union of subordinate sounds with the fundamental tone. (See Daguin, tome 1, pp. 469, 485.) But it was universally held and taught, we believe, that the origin of timbre probably lay in the peculiar orbit of the vibrating particles of the soniferous medium, because the periodic time of these particles being appropriate to pitch and to amplitude of their excursions (orbits) to intensity, there was really nothing left for 'timbre' but the configuration of the orbit. Helmholz's discovery of the independence of timbre and phase, shows that difference of timbre is accompanied by difference in the orbital motion of the particles of the sound-conductor, yet identity of timbre is compatible with marked difference in the distribution of density in the sound-wave and so in the extension of the particles. How beautifully is the physical law explained by even the partial knowledge we have of the nature and structure of the labyrinth of the human ear! Helmholz finds in Corti's organ and Schultze's bristles, an instrument adapted to analyze a complex sound, without reference to the *phase* of its components. Dr. Tyndall strangely notices this structure of the ear, without adverting to the remarkable physical law which it explains.

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* Die Lehre von den Ton empfindungen, 1865.

In the midst of so much that is true and beautiful in the book, it is almost invidious to notice minute defects, yet we must say that the word '*obertoene*' seems not to be happily rendered by *overtones*. The latter word suggests *dominant* rather than *higher* tones.

It is to be remarked too that the snow-fall, mentioned on page 19, appears to have had an effect upon *timbre*, not noticed by the Dr. and indeed previously entirely unsuspected. It changed good French into bad French. But perhaps the guides fell into a crevasse, in which case the exclamation '*nous sommes finis*' was quite natural. s.

3. *Guyot's Geographical Text Books;* 1, Primary; 2, Intermediate; 3, Common School. New York, C. Scribner & Co.—These three volumes are likely to attract the attention of all who see them because of their beautiful engravings and maps, and because of their clear and satisfactory typography; but these are minor merits. The true value of the series consists in the fact that it is prepared by one who is a master of the science which he treats and who is also a skillful and experienced teacher, well acquainted with the requirements of American schools. Such text-books are so rare in the educational literature of this country, and the number of "manufactured" text-books, prepared by incompetent persons is so great, especially in elementary science, that all who are interested in the promotion of thorough education and the diffusion of true science should welcome the appearance of new manuals which can honestly and heartily be commended. The highest praise in our opinion is due to the Geographical series of Professor Guyot. If the largest volume of the three could be made the basis for a thorough examination of candidates for admission to the college and the scientific school, we are confident that the higher education of the young men would be much easier than it is at present, when their geographical training is admitted to be disproportionately defective. The Guyot books are the only geographies which we know of in the language recognizing throughout, the fundamental, natural characteristics of every region on the globe. The scholar is made familiar at the outset of his studies with the aspects of Nature, and he is soon led to discover that the physical peculiarities of the different countries underlie, and to some extent control national and political characteristics. This familiarity is carried at every step into more and more detail. We shall not be surprised if teachers who are only familiar with such geographies as chiefly tax the

memory by requiring the acquisition of long lists of names, at first pronounce the Guyot series strange and hard; but we are persuaded that if they will carry a single class through either book, they will find that the reasoning faculties of the pupil have been trained as well as the memory; and that the powers of judging, comparing and of image-forming has been very greatly enlarged. Since Geography is the one study involving an acquaintance with the world of nature, which has been gradually introduced into the common schools, it ought to be taught on right principles, and now for the first time among us this is possible.

The maps which illustrate the Guyot books are admirably prepared, so as to exhibit at once, natural features and political divisions. They are free from unnecessary details and present important general truths in a bold, impressive manner. Some of these maps are the best cheap maps which can readily be obtained for any purpose, those of our own country having original merits of especial value. We have repeatedly commended them to those who were in search of a trustworthy atlas at a moderate price.

In the literary preparation of these books, Prof. Guyot has been assisted by Mrs. Mary H. Smith, of the Oswego Training School, a very competent teacher, and thus it is thought that his books have been made still more acceptable to American instructors.

The wall-maps, which are issued by the same publishers, and are prepared by Mr. Guyot and his associate, Mr. Landoz, are an excellent accompaniment of the text-books, and they are of great independent value. They may be had in any one of three dimensions according to the room for which they are designed. The larger sets are admirably adapted to college lecture rooms and academies, and the smaller to ordinary schools.

4. *A Journey in Brazil;* by Professor and Mrs. LOUIS AGASSIZ. 540 pp. 8vo, with several plates. Boston, 1868. (Ticknor & Fields.) —This work on the Brazilian expedition of Professor Agassiz, whose departure was announced in the volumes of this Journal for 1865, has a double interest from its joint authorship. The Journal of Mrs. Agassiz is full of interesting incident and description, written in a graceful and attractive style. Prof. Agassiz has added to the chapters the results of many of his important scientific observations, made by sea and land, on his favorite topics, fishes and other life of the sea and rivers, distribution of species, glaciers, and general geology. A book notice does not afford space for presenting or discussing the views brought forward. The work is published in the best style, and is illustrated by plates giving excellent views of the scenery about Rio Janerio, Para, and the plains of the Amazon; though wood-cuts, several of them might be taken for steel-plate engravings.

Geological Survey of California. Paleontology. Vol. II, Section I, Part I, Tertiary Invertebrate Fossils. Plates. (13 plates, from drawings by the Paleontologist, W. M. Gabb.)

Organic Philosophy. Vol. II; outlines of Ontology: Eternal Forces, Laws and Principles; by Hugh Doherty, M.D. 456 pp. 8vo. London, 1867. (Trübner & Co.) Received too late for a notice.

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[SECOND SERIES.]

ART. XXX.—*On the Musical Ratios, and our Pleasure in Harmonious Sounds;* by HENRY WARD POOLE.

UTILITY, in a liberal sense, may be assumed to be the goal of scientific investigations. We should all rejoice if the discoveries in heat should lead to material results in making available those immense forces which are said to result from the burning of a pound of hydrogen or of coal. It would be gratifying if the laws of light shall be so far understood, that we can have photographs fixed with the colors shown in nature. In the department of sound, utility seems to be almost entirely confined to the musical department, where complicated vibrations and relations are excluded, and only the simple and regular are admitted. And here, strange to say, in all times, the practice has been in advance of the science.

Singers and players have used, and still are using, intervals which please themselves and their auditors, while the scientists have not known that they used them, and have declared that really harmonious sounds are discordant and harsh.

To illustrate this assertion, I take the last and most complete work on Sound* that I have seen. The excellence of other parts of this work, and the high merits of the author, make it noteworthy that after such minute experiment with metal and wooden rods, disks, singing flames, etc., the higher department should have received so little attention.

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* Sound. A course of eight lectures delivered at the Royal Institution of Great Britain, by John Tyndall, LL.D., F.R.S. London. 1867.

But although every singer and musician may have his inner revelation of what musical intervals really are, it is important that they should be understood and acknowledged by the scientific, and the teachers of music.

It is not difficult to find a pair of children, or a quartette of friends, who will sing in perfect tune. But in nearly every church and music room is set up an organ with but twelve pipes in each octave, which can not make a perfect chord, or one which would be tolerated by the vocalists referred to. What is the fault of these instruments ? Can instruments be made and played in perfect tune ? First of all, what are the notes, the scales, the harmonies, which composers write and artists execute ? These are some of the questions whose resolution leads to useful results. The ignorance of teachers leads to the mischief, that they spoil good singers, by compelling them to take intervals from imperfect instruments. An example will show what I mean. Nothing is more common than to sing a seventh, ratio 4 : 7, on the dominant harmony, concordant, and as any one would wish to give it. The theoretical books would have this given as 9 : 16, or about a seventh of a tone too high. A teacher by the rude instruments now in use, would require the pupil to sing the interval with something like this error. The effect on a good singer is to deaden his sensibility and consequently spoil him. It is remarkable that this interval of 4 : 7 is not recognized by Professor Tyndall, who has, apparently, aimed at giving what is known up to the present time. That such an interval is used and is harmonious has been published in this Journal, eighteen years since, and elsewhere.

Euler gives a good theory, which Professor Tyndall quotes as follows.

> Euler analyses the cause of *pleasure.* We take delight in *order.* It is pleasant for us to observe 'means co-operant to an end.' But then the effort to discern order must not be so great as to weary us. The simpler the terms in which the order expresses itself, the greater is our delight. Hence the superiority of the simpler ratios in music over the more complex ones. Consonance, then, according to Euler, was the spiritual pleasure derived from the perception of order without weariness of mind.

I approve of Euler's explanation but not of Professor Tyndall's statement. I understand that the musical ratios collectively are the simplest of the mathematical ratios, and that these are *equally and entirely perfect and agreeable when duly used in music.*

But our author states that the unison, 1 : 1, is the most *perfect.* Next comes the octave, 1 : 2, still very harmonious.

Next, the fifth, 2 : 3, is "very pleasing, but the consonance is hardly so perfect as in the last instance; there is a barely perceptible roughness here. Next to the octave, this is the most pleasing combination." The "roughness of the fourth, 3 : 4, is a little more pronounced." The harmony of the major third 4 : 5, is declared "less perfect," and that of the minor third, 5 : 6, "usually [?] less perfect still." And he declares the law that "*the combination of two notes is the more pleasing to the ear, the smaller the two numbers which express their vibrations.*"

No ratio higher than 5 : 6 is mentioned, except 13 : 14, which is declared "altogether discordant." As a reason, it might be stated that the prime 13 is far beyond the limit of musical ratios. The ratios 6 : 7, 5 : 7, 7 : 9, and all reference to the chords derived from seven, are omitted by Professor Tyndall in this course of lectures. But he says that musicians have chosen the simple intervals "empirically, and in consequence of the pleasure they gave, long before any thing was known regarding their numerical simplicity."

If musicians have chosen the most simple intervals as most pleasing, it is not true that they have considered fifths as inferior to octaves, or the latter as less pleasing than unisons. All the intervals named, and those of the harmony of the seventh with their inversions and derivatives, within due limits and properly combined, are entirely perfect and equally pleasing, one with the other. Beyond these limits, all are incomprehensible and alike unharmonious. Theorists have improperly classed fifths as "perfect concords," thirds, as "imperfect concords," and worst of all, the beautiful concord of the seventh, 4 : 5 : 6 : 7, is called a "discord." It is difficult to say why such distinctions were made, unless they came from the imperfect tuning of the keyed instruments which these theorists used.

It appears that Professor Tyndall treats the coincidences of harmony and those of discordant vibrations under the same term; viz., "beats." And, following Helmholtz, he says that beats of 33 per second, are in their "condition of most intolerable dissonance;" and that "with higher rates than 33 the roughness lessens until at 132 it totally disappears." He then examines the several chords, as follows, beginning with the octave:—

Here our rates of vibration, are

512—256; difference=256.

It is plain that in this case we can have no beats, the difference being too high to admit of them.

Let us now take the *fifth.* Here the ratios of vibration, are

384—256; difference=128.

This difference is barely under the number 132, at which the beats vanish; consequently the roughness must be very slight indeed.

Taking the *fourth*, the numbers are

384—312; difference=72.

Here we are clearly within the limit where the beats vanish, the consequent roughness being quite sensible.

Taking the *major third*, the numbers are

320—256; difference=64.

Here we are still further within the limit, and, accordingly, the roughness is more perceptible.

Thus we see that the deportment of our tuning forks is entirely in accordance with the explanation which assigns the dissonances to beats. pp. 299–300.

There is an evident error in the numbers assigned to the fourth. As four tuning forks are mentioned, they are probably those of the key-note, its octave, fifth, and major thirds. The interval of the fourth, then, would be obtained by sounding the fifth with the octave; giving

512—384; difference =128

which would give to the fourth the same "roughness" as to the fifth.

If coincidences in the vibrations of simple chords be what is meant by "beats," it would be easy to show that 33 such beats per second are not necessarily disagreeable. It is stated that 33 vibrations give a "perfect musical tone." If we sound with this its *octave* with 66 vibrations, we shall have a still more agreeable musical effect, as always results from such addition to a very low note—and there will result just 33 coincidences, or so called beats. But if we should add a fifth, with 49·5 vibrations, the effect would not be so good. A major third, with 41·25 vibrations would be intolerable, yet the "beats" would be just 33 in each case. Why is this difference? The answer is found by examining the harmonic series:

1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 : 10.

It is found that the several prime chords, fifth, third, etc., are most sonorous and agreeable when taken in the relative position as above. Assuming that the lowest sound has 33 vibrations per second, its octave follows with 66, the fifth to the last 99, the major third, to the double octave, with five times 33, or 165, and the seventh with seven times 33 or 231. The rule being as follows:

The vibrations of the lowest notes which it is permissible to use in the relations of fifth, major third, or seventh, are in the relations respectively, as the numbers 3, 5, 7. The lowest audible sound may be the limit for sustained or final chords, and

If so, the fifth must have at least three times its number of vibrations, the third five times, and the seventh seven times. At all events these different chords will always keep these relative positions, or a fifth can always be sounded lower than a third, and both lower than a seventh; which accords with the practice of musicians. For certain melodic movements, it would seem as if all these intervals can be taken about an octave lower than the limiting note of 33 vibrations would permit. Can not the vibrations of the octave below, or 16½, be *felt* in union with the octave and other harmonics above, and in this way be considered as audible? For the musical ear hears only what is plain enough to be understood, and relations too remote are often made clear and agreeable by the addition of other sounds. So a note in combination may be audible, which alone is not so.

Composers know the variety and advantages which result from taking chords in their various inversions, positions and distributions; but it is certain that the harmonic series shows the best order and the proportion of each element admissible. Thus, before the seventh is sounded, we have the fundamental note in three octaves, the fifth in two, and the major third only in one.

Professor Tyndall says much about the harmonics, which he calls "overtones." He says:

> And be it remarked, that the overtones are indispensable to the character of musical sounds. Pure sounds, without overtones, would be like pure water, flat and dull.

I believe that pure water is good, either to use in its purity, or to mingle with other elements at pleasure, and that pure sounds are most desirable in singers and in instruments. It was a triumph when the piano-forte was made to give less of the jangling harmonics, and more of the pure fundamental tone of the string. He says that in the organ, the overtones are so much felt to be a necessity, that they are introduced by small pipes, that "in fact, a good musical clang requires the presence of several of the first overtones."

It is asserted by Professor Tyndall that the vowel sounds are due to accompanying harmonics, and that the quality of sounds is also owing to their distinctive harmonics. That a flute sounds differently from a violin is owing to the fact that every flute has certain harmonics, while a violin has others. But one violin sounds different from another, and the material of a tube alters its quality of tone. Each instrument has the characteristic quality of its class, and besides, something distinctive of itself. There does not appear enough evidence to show that this varied *quality* of tone is owing to such simple cause as what is understood by harmonic tones. If this were true, the perception of the distinctive qualities would be easy, and in the department of a musical ear. But quality of tone in general, is not especially noticed by the musician, who only deals with certain simple and regular forms of vibration. The unmusical ear recognizes as quickly the tone of a voice, or that ring which tells that a dollar is made of silver. One can imagine that the infinite variety in the quality of tones is owing to some difference in the conditions and forms of their vibrations, which the ear distinguishes by some wonderful faculty which is not the higher perception of music. Such power of distinguishing by the different senses is possessed even by the lower animals; in some cases beyond the power of man.

Quality of sound is so little understood at present that distinctive terms are wanting. We speak indeed, of a loud sound, which is one that can be heard at a long distance; of a pure sound, called also smooth, sweet, and even soft, although the tone may be powerful. Any term expressing agreeable qualities to any of the the senses is applied to pleasant sounds. For example we have a *brilliant* tone, borrowing the word from the sense of sight, a *harsh* or *rough* sound, as if to the sense of touch. When, in the theatre, music is desired, very pure in quality and in tune, and soft and even in power, it is technically known as "aerial music." We shall be glad to have more definite knowledge concerning the qualities of tone, but it depends on something outside of the harmonic sounds.

In extension of the theory that beats of 33 per second are the most offensive possible, and that those of 132 are harmless, Professor Tyndall gives the several chords from the octave to the minor third, accompanying each note by its harmonic to the tenth degree. The octave is as follows:

		1	:	2
Fundamental Tone,		264		528
Overtones,	1	528		1056
	2	792		1584
	3	1056		2112
	4	1320		2640
	5	1584		3168
	6	1848		3696
	7	2112		4224
	8	2376		4752
	9	2640		5280

Comparing these tones together in couplets it is impossible to get out of the series a pair whose difference is less than 264. Hence as the beats cease to be heard when they reach 132, dissonance must be entirely absent from the combination which we have just examined. The octave therefore is an absolutely perfect consonance.

There is something strange in calling a combination harmonious because the rapidity of the discordant beats is so great that they are inaudible. The fact is, that a chord is nearly in tune and begins to give agreeable effects when its beats are very slow. When the chord is more out of tune and the beats become rapid, and mingle in a flutter, whether of 132 a second or more, the ear ceases to regard the sounds as a chord; but it cannot be said that "dissonance must be entirely absent;" on the contrary it is terribly present.

Whether the twenty sounds given above be harmonious or not, it can be shown that this does not depend on the circumstances that there are no coincidences less than 132. For twenty other sounds might be added at random utterly discordant, but not beating slower than 192. For example, 265 : 529, 266 : 530, etc., all having the difference of 264. And in all the examples given, the addition of the overtones does not effect the case, for if the fundamental tones have the desired difference of 132, the first harmonic is sure to have twice this difference, and the others still more. But a point might have been made, which has been overlooked by Tyndall, in the circumstance that these overtones make a "rough" chord more harmonious. See the major third, 4 : 5, 330−264=difference 66, and the minor third, 5 : 6, 396 − 330=difference 66. These are called rough, because their differences are less that 132. But their first harmonics have a difference of 132, and all the following differences are far beyond the assumed limits of dissonance. But the whole theory is untenable.

If the effect is good when each note is accompanied by harmonics, the reason will be found in the simple relations which exist, and in the circumstance that what would be complicated alone, may be clear when auxiliary sounds are present.

After asserting the equality of the musical ratios in composition, I admit the superiority of the simpler ratios for modulations. A change of key is best made to the fifth above or below, by the ratios 2 : 3, or 3 : 4. If the change by an octave, 1 : 2, be considered as a modulation, it is an extremely simple one. But modulations do not seem practicable by a third or seventh, or the primes 5 and 7. Such a change would sound like an abrupt transition.

In rhythm again, no other primes than 2 and 3 have been found available. A single composition has been made with *five* beats, or supposed equal divisions, in the bar, but no one desires to sing it or hear it a second time. It may be said that double time, in general, is more satisfactory than triple; and because it is simpler. Yet the waltz movement is perfectly clear to most lovers of music. The rhythm which results from joining three doublets or two triplets in a single measure gives an agreeable variety.

Although Professor Tyndall remarks that it is not his "vocation to lead into the musical portion of Acoustics," it is to be wished that so able a man would do so. The physical portion of musical acoustics, and the definition of musical intervals have also been omitted by a late lecturer on Harmony at the Royal Institution (G. A. Macfarren, 1867). Unless the intervals be defined, nothing is to be learned from a lecture on harmony, beyond what can be seen by studying the works of musicians directly. Let the syren be improved so as to give chords with the number 7, and let reed-pipes give the various chords and melodies. Let us know the exact pitch of every note. Musical notation is a sort of short hand, which may not be understood by a mechanical player. One who understands harmony knows what the composer meant in all cases where the composer himself knew it.

South Danvers, Mass., Feb. 1868.

Since writing this paper with regret at the neglect musical science has received, I have had the pleasure of learning that they are doing better in Germany. First, I read the admirable book on the training of the " Voice in Singing," by Mrs. Emma Seiler, late of Heidelberg, and co-laborer with Dr. Helmholtz, in this department, and now established in successful teaching in Philadelphia. Mrs. Seiler has studied the action of the vocal organs from life, and describes the meaning of the "registers" or the several methods of producing tones. She shows how these are to be developed, protected from injury by straining under bad instruction, and made to sing easily and truly. For want of such knowledge we have few good singers. Soprano voices are undeveloped or ruined, and the falsetto register of tenors is no longer used. Yet the great Italian masters used to train tenors with a full and strong falsetto, which united with the chest voice imperceptibly, and continued upward easily and purely. Now the tenors go as high as the chest voice can be painfully urged, and consider it something great if they get up to the *a*. In old times good singers used to preserve their voices to old age. We had here such trained tenors when the English Glees were sung. The following shows that Mrs. Seiler deserves her high reputation as a scientific teacher, and insists on singing in perfect tune.

> Purity in the art of Singing is, however, such a primal condition of its beauty, that a piece of music purely executed, even by a weak and slightly cultivated voice, always sounds agreeably, while the most sonorous and practised voice offends the hearer when it is out of tune or forced upward. The training of our singers by pianos, as they are now tuned, by equal temperament, is altogether unsatisfactory. The singer who practices with the piano has no safe principle by which he can measure the height of his tones with any exactness. But persons of good musical talent, made aware of this disadvantage by a competent teacher

and practicing accordingly, can nevertheless overcome this difficulty caused by our present method of tuning, and learn to sing correctly and purely.[*]

Dr. Feyjoó, who, in his time did most to enlighten Spain, was learned in music, and explained what the "enharmonic" meant. In his convent at Oviedo, in 1734, he thus exalts pure intonation, which is the "unknown charm" of singing, the "*no sè què*," which one has and another has not.

> "Could I hear this voice," says he, "I would tell you what is the attractiveness which you call occult. * * * *Perfection of intonation* is a beauty which is occult to the very musicians. Let us not mistake each other. The musicians distinguish very well errors in intonation up to a certain degree; those of a comma, a half comma, or, I will allow you, a quarter comma; so that those who have a delicate ear, although the error is so small, perceive that the voice does not strike with complete exactness, though they cannot tell the amount of the error. But when the error is much less, as the eighth of a comma, no one thinks the voice is not true. But for all that this defect is so small as to escape the reflection of the understanding, it makes a sensible effect upon the ear; and the composition does not please as much as if it were sung by another voice, which should give the intonation more justly. * * * This unknown something, when deciphered, is the just, the perfect intonation."—*Theatro Critico*, tom. vi, p. 432.

I have also just received the large work of Dr. Helmholtz,[†] of which I can only notice, among much that is highly interesting, that which relates to pure Intonation. He also declares that musical harmonies should be given purely. He has even invented and built a "Harmonium" with perfect tuning. It has 24 notes, and 4 pedals or registers, each controlling 3 notes of a group *a*, and 3 of a group *b*. The key-notes are in a true series of fifths, like my own. Gen. Thompson's enharmonic organ is noticed, and others made in Europe,—nothing from the American side. Notes a comma apart are distinguished by large and small letters as I have done,—originally as I thought,—in this Journal of July last; which plan seems to have been used, previously, by Hauptmann. The harmonic seventh, 4 : 7, is discussed, and in some degree admitted, after ages of constant service in the art, to a place in German musical science; my long neglect of the German language and shortness of time, have not yet allowed me to learn all I would wish about the treatment of this favorite protégé of mine. But there are signs of general progress regarding pure vocal music and its auxiliary instruments, and a rational theory of Harmony.

I am obliged to omit a description of a new "*Enharmonic Vocal Intonator*" for training singers in pure intervals, and for accompanying. It gives full harmonies to the tenth degree—1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 : 10—plays these chords altogether, or any part of them, and in *arpeggios;* is more easy to play than the guitar and as portable; plays melodies, but chords most easily, being peculiarly constructed for that purpose; has all the harmonies for the major and minor, as in my enharmonic table (this Journal, July, 1867); plays very softly, or loud enough to accompany a choir; and, finally, can be made for the cost of a good guitar. H. W. P.

March 20, 1868.

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[*] The Voice in Singing, translated from the German of Emma Seiler. [By Dr. W. H. Furness.] Philadelphia. 1868.

[†] Die Lehre *von den* Tonempfindungen als Physiologische Grundlage für die *Theorie der Musik. Von H.* Helmholtz. Braunschweig, 1865. 2d ed., 605 pp. 8°.

ART. XXXI.—*On the measurement of wave-lengths by the method of comparison.* Abstract of a paper read before the National Academy of Sciences, Aug. 16, 1867; by WOLCOTT GIBBS, M.D., Rumford Professor in Harvard University.

IN a memoir on the construction of a normal map of the solar spectrum, I have given a method of determining wave-lengths which I believe to be new, and which I have termed the method of comparison. This method is analogous in principle to one frequently employed by astronomers, and consists simply in measuring, upon an arbitrary scale, the distance between the given line and one or more lines, the wave-lengths of which have already been determined. If the relation between the scale-numbers and the corresponding wave-lengths is known, it is easy to determine the wave-length of the given line by calculation.

In the paper above referred to, I have given a complete reduction of Kirchoff's scale, based upon the wave-lengths measured by Ditscheiner. To determine the relation between the scale-numbers and wave-lengths, I employed the graphical method of interpolation, and have given the results in tabular form. In the present paper, I shall give the results of a new reduction of the same scale, in which I have exclusively employed the method of interpolation given by Cauchy, for a knowledge of which I am indebted to Professor Winlock. For the purpose which I had in view this method is very much more convenient and expeditious than that of least squares. The relation between the scale-numbers and wave-lengths is given by an expression of the form

$$\lambda = a + bk + ck^2 + dk^3, \text{ \&c.}$$

In some portions of the scale a parabola of the 5th order is required. In this second reduction I have exclusively employed Ditscheiner's measurements of the wave-lengths, after reducing them, as before, so as to correspond with the value given by Angström for Fraunhofer's line D. As Ditscheiner has given the number of measurements made to determine each wave-length, I have been able to give weights to the wave-lengths employed in the computations. For convenience in discussion, the 106 scale-numbers, the wave-lengths of which are given by Ditscheiner, were divided into twelve groups, nine of which embraced ten measurements for each group, while the tenth group contained twelve, the eleventh eight, and the twelfth seven measurements.

In each group, the initial point is the last scale-number of the preceding series, which is, of course, equivalent to connecting the ends of the different parabolic curves representing the successive groups.

In Table I, the elements of the computation and the differences between the wave-lengths, as actually measured and as computed by the formulas, are given. Column N gives the number of each element, W the weight, K the scale-number, λ the observed wave-length, and Δ the difference between the observed values of the wave-lengths and the values calculated by the constants given in Table II. It must be borne in mind that the sign + or − refers to the excess or deficiency of the observed over the calculated wave-lengths. The column ε gives the probable error in the case of each group; it may also be considered as expressing the probable error in the determination of any wave-length by the method of comparison, for a particular portion of the scale.

TABLE I.

N	W	K	λ	Δ	ε	N	W	K	λ	Δ	ε
1	9	694·1	656·65	0·00		37	9	1421·5	537·50	0·00	
2	2	711·4	652·07	−0·06		38	9	1450·8	534·49	−0·02	
3	2	719·6	650·03	+0·02		39	18	1463·3	533·27	+0·04	
4	1	783·8	634·23	+0·08		40	6	1492·4	530·21	−0·09	
5	4	831·0	623·59	+0·08		41	6	1506·3	528·77	−0·18	
6	4	849·7	619 60	0·00		42	7	1515·5	527.99	+0·10	
7	7	860·2	617·48	0·00		43	19	1523·7	527·42	+0·07	
8	8	863·9	616·71	−0·04		44	2	1541.9	525 97	+0·20	
9	6	874·3	614 72	0·00		45	8	1569·6	523·72	+0·05	
10	9	877·0	614·23	0·00	±0·04	46	8	1577·6	523 08	−0·05	±0·08
10	9	877·0	614·23	+0·05		46	8	1577·6	523·08	−0·01	
11	7	884·9	612·75	0·00		47	1	1589·1	521·96	−0·21	
12	7	894·9	610·80	−0·06		48	6	1601·7	521·31	+0·12	
13	2	958·8	598·12	−0·02		49	4	1622·3	519·65	+0·03	
14	11	1002·8	590·07	−0·05		50	18	1634·1	518·71	−0·03	
15	18	1006 8	589·43	−0·02		51	14	1648.8	517·68	+0·01	
16	4	1029·3	586·25	+0·35		52	13	1655·6	517·13	−0·05	
17	3	1096·1	576·71	−0·13		53	6	1693·8	514 63	+0·16	
18	3	1102·9	575.77	−0·18		54	4	1737·7	511·41	+0·05	
19	8	1135·1	571·49	+0·06	±0·13	55	4	1750·4	510·28	−0·16	±0·10
19	8	1135·1	571·49	0·00		55	4	1750·4	510·28	−0·02	
20	2	1155 7	568·69	+0·02		56	6	1777·5	508·39	−0·02	
21	10	1174 2	566·32	+0·09		57	5	1799·0	506·89	−0·04	
22	5	1200·6	562·95	+0·07		58	13	1834·3	504·54	+0·03	
23	16	1207·3	561·96	−0·08		59	5	1854·9	503·24	+0·12	
24	9	1217.8	560·75	0·00		60	5	1867·1	502·25	−0·05	
25	8	1231.3	559·12	0·00		61	2	1873·4	501·66	−0·23	
26	7	1242·6	557·76	0·00		62	7	1885·8	501·05	−0·01	
27	10	1280·0	553·25	−0·06		63	4	1908·5	499·70	+0·12	
28	1	1303·5	551·11	+0·59	±0·16	64	6	1920·2	498·76	−0·07	±0·08
28	1	1303·5	551·11	+0·28		64	6	1920·2	498·76	0·00	
29	2	1306·7	550·68	+0·26		65	17	1960·8	496·14	+0·01	
30	12	1324.8	548·11	−0·07		66	2	1975·7	495·03	+0·08	
31	3	1337·0	546·76	+0·02		67	7	1983·3	494.33	0·00	
32	8	1343·5	546·03	+0.04		68	6	1989·5	493.75	−0·05	
33	5	1351·1	545·06	−0·07		69	7	2005·2	492.31	−0·15	
34	10	1367·0	543·40	+0·04		70	3	2118·5	491.39	+0·07	
35	*11*	*1389·4*	*540·90*	−0·04		71	9	2041·3	489·52	+0·09	
36	*1*	*1410·5*	*538·77*	+0·09		72	2	2058·0	488·16	0·00	
37	*9*	*1421·5*	*537·50*	0·00	±0·12	73	9	2067·1	487·53	0·00	±0·06

TABLE I—(Continued).

N	W	K	λ	Δ	ε	N	W	K	λ	Δ	ε
73	9	2067·1	487·53	−0·03		93	1	2547 2	450·12	+0·44	
74	21	2080·0	486·49	+0·06		94	9	2566·3	448.45	−0·05	
75	1	2103.3	484·62	+0·32		95	7	2606·6	445·99	+0·05	
76	8	2119.8	482·80	−0·16		96	4	2627·0	444·63	0·00	
77	1	2148·9	480·54	+0·23		97	7	2638·6	443·83	−0·05	
78	1	2157.4	479·53	−0·03		98	8	2670·0	441·87	−0·01	
79	3	2160.6	479·21	−0.19		99	7	2686·6	440 86	+0·01	
80	6	2187·1	476·92	−0·18		00	12	2721·6	438·74	0·00	±0·15
81	3	2201·9	475·89	+0·09							
82	2	2221·7	474·33	+0·22							
83	5	2233·5	473·35	+0·30							
84	2	2250·0	471·24	−0·38	±0·22						
84	2	2250·0	471·24	+0·02		00	12	2721·6	438·74	+0·15	
85	4	2264·3	470·69	+0·05		01	7	2734·9	437·79	+0·09	
86	12	2309·0	467·06	−0·02		02	8	2775·7	435·66	+0·14	
87	5	2416·0	460·61	+1·06		03	11	2797·0	434·32	−0·33	
88	5	2436·5	458.65	+0·34		04	11	2822·8	433·80	+0.23	
89	3	2457·5	456·80	+0·18		05	17	2854·7	431·34	−0·25	
90	6	2467·6	455·70	−0·20		06	7	2869·7	430·36	+0·26	±0·28
91	8	2489·4	453·71	−0·66							
92	2	2537.1	450·54	−0·46							
93	1	2547·2	450·12	−0 17	±0·66						

Table II* gives the values of the constants *a*, *b*, *c*, *d* and *e*, as deduced from the elements given in Table I. In this table column 1 gives the initial and column 2 the terminal point upon Kirchoff's scale for each curve. It will be remarked that, in one instance, the observations are best represented by a straight line.

TABLE II.

	1	2	*a*	*b*	*c*	*d*	*e*
1	694·1	877	656·65	−26·325	+1·0490	+0·3618	......
2	877	1135·1	614·19	−17·670	−5·5610	+4·6190	−0·8910
3	1135·1	1303·5	571·47	−14·008	+1·5466	−0·3707	......
4	1303·5	1421·5	550·82	−12·842	+2·1860	−0·7367	......
5	1421·5	1577·6	537·49	−10·063	−0·6920	+0·7960	......
6	1577·6	1750·4	523·09	− 8·125	+0·8911	−0·2463	......
7	1750 4	1920·2	510·30	− 6·792	−0·1661	+0·1180	......
8	1920·2	2067·1	498·76	− 5·029	−3·4550	+1·6630	......
9	2067·1	2250·0	487·45	− 5·026	−8·9870	+7·7820	−2·190
10	2250·0	2547·2	471·24	− 7·048	......	......	......
11	2547·2	2721.6	449·67	− 6·154	−0·4536	+0·2028	......
12	2721·6	2869·7	438·58	− 8·129	+2·1490	+1·5740	−1·6350

A very slight examination of the column of differences, in Table I, will serve to show the marked irregularity of certain portions of Kirchhoff's scale. It is worthy of notice that this irregularity occurs, for the most part, precisely in those portions of the scale which we should expect *a priori* to find most uniform; it is, however, easily explained by the frequent variations in the position of the prisms in the spectroscope employed. It is not to be denied that the advantages of the method of comparison in the determination of wave-lengths will more fully appear when an extended spectrum shall have been drawn with the data yielded by a spectroscope in which, as in that of Mr. Rutherfurd, all the prisms are in the position of least deviation for each ray in succession.

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* In using the constants in Table II for computing wave-lengths the value of *k is to* be found by subtracting the initial number in column 1 from the scale number and dividing the remainder by 100.

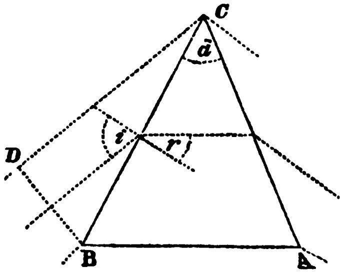
In my former paper, I have given a method of comparing a given spectrum directly with Kirchoff's chart, by means of a particular arrangement of the scale telescope. I have since found that it is simpler and better to employ a camera lucida attached to the eye piece of the observing telescope. The chart is placed upon the table below and serves to identify the lines. To find the position of a single line, as for instance the green thallium line, upon the chart by comparison, one-half of the slit of the collimator must receive direct sunlight while the other half receives the light of the flame containing thallium, the camera lucida and chart being adjusted in the manner already described. A filar micrometer may, also, be employed with great advantage whenever the field of view contains, at the same time, the line the wave-length of which is to be determined, and one or more other lines of which the wave-lengths are known, or which can be identified upon the chart by means of the camera lucida.

Cambridge, March 6, 1868.

Art. XXXII.—*On the Comparative Efficiency of different forms of the Spectroscope;* by Edward C. Pickering.

It is the object of the present paper to furnish a means of comparing with accuracy spectroscope prisms of different forms, and to determine what must be their refracting angle, to produce the greatest dispersion, with the least loss of light. We have then to consider the dispersion, the loss by reflection, and that by absorption.

1. *Dispersion.*—The dispersion of any part of the spectrum, is proportional to the angular interval between two rays of nearly equal refrangibility, as the two parts of a double line.



Let α be the refracting angle of the prism ABC, n the index of refraction of the less refrangible ray. *For minimum* deviation,

$r=\frac{\alpha}{2}$, $\sin i=n\sin\frac{\alpha}{2}$ . . . . . (1). If dn be the difference of the indices of refraction of the two rays, di will be their angular divergence. Differentiating (1), $di=\frac{\sin\frac{\alpha}{2}}{\cos i}dn=\frac{1}{n}\tan i\,dn$ . . (2), in which $\frac{1}{n}$ tang i serves as a measure of the dispersion under different angles of incidence. It differs essentially (when the angle of incidence is large) from the deviation which is commonly, but incorrectly, assumed as the measure.

Comparative dispersion and deviation of a ray entering a medium in which n=1·5.

Angle of incidence i,	0°	15°	30°	45°	56° 19′	60°	75°	80°	85°	90°
Dispersion $\frac{1}{n}$ tang i,	·0	·179	·385	·667	1·000	1·1565	2·488	3·781	7·620	∞
Deviation $i-r$,	0°	5° 4′	10° 32	16° 53′	22° 38′	24° 44′	34° 55′	38° 58′	43° 23′	48° 11
" reduced to same unit as dispersion,	·0	·231	·465	·746	1·000	1·093	1·543	1·720	1·917	2·121

The dispersion then increases much more rapidly than the deviation; hence in spectroscopes whose deviation is the same, that one will disperse most, in which i and therefore α is the greatest.

The above discussion applies strictly only to the emergent ray, but in the position of minimum deviation, the dispersion of a prism is just double this, as may be seen from the general formula for dispersion (Radicke's Optics, vol. i, p. 179). I propose hereafter to discuss the question whether greater dispersion with the same loss of light could not be obtained by some other position of the prism.

2. *Reflection.*—In estimating the loss by reflection it is usual to assume that the same proportion of the incident light is lost at each successive refraction. But in reality the light so refracted is partially polarized, and in this state another law determines the amount reflected. Fresnel showed that of a ray polarized in the plane of incidence, the proportion reflected $B'=\frac{\tan^2(i-r)}{\tan^2(i+r)}$, while a ray polarized in a plane perpendicular to the first, would lose by reflection $A'=\frac{\sin^2(i-r)}{\sin^2(i+r)}$.

Regarding common light as composed of two beams of equal intensity polarized at right angles, the amount reflected would be $\frac{1}{2}A'+\frac{1}{2}B'$, and that transmitted $\frac{1}{2}[(1-A')+(1-B')]$. On meeting a second surface inclined at the same angle of incidence, the amount transmitted would be $\frac{1}{2}[(1-A')^2+(1-B')^2]$ and after passing m surfaces $\frac{1}{2}[(1-A'^m)+(1-B')^m]$.

This formula can be applied directly to the m surfaces of the prisms of a spectroscope, since in the position of minimum deviation i and r are the same for all, and therefore the amount transmitted is the same, whether the passage is from glass to air, or from air to glass.

The formulas of Fresnel are used in preference to those of Cauchy, although the latter have been proved, by Jamin and others, to be more correct. But the coefficient of ellipticity which they involve is neither so commonly, nor so easily found as the index of refraction. Furthermore, for glass the difference would probably be so small that it could be neglected.

3. *Absorption.*—The average length of glass traversed by the light is one half the base AB, multiplied by N the number of prisms, and the amount escaping absorption is proportional to the log. of this distance, or to $\log N\times BC\sin\frac{1}{2}\alpha$, or in prisms admitting the same amount of light (that is in which BD is the same) to $\log BD\times N\frac{\sin\frac{1}{2}\alpha}{\cos i}$, since $BC=\frac{BD}{\cos i}$, but the dispersion is proportional to $N\frac{\sin\frac{1}{2}\alpha}{\cos i}$, hence in spectroscopes dispersing equally and composed of prisms of the same material, *the loss by absorption will be the same in all*, so that as far as the absorption is concerned, it makes no difference whether a spectroscope is composed of a large number of very acute angled prisms, or of a less number in which the angle is more obtuse.

Thus we avoid a difficulty which seemed at first sight insurmountable, since the actual amount of light absorbed varies not only with the material, but with the refrangibility of the rays, and according to laws not yet discovered.

The following tables give the deviation, dispersion, and amount of light escaping reflection, of spectroscopes composed of from one to ten prisms of indices of refraction 1·5, 1·6 and 1·7.

TABLE I.—45° *Prisms.*

	n	1 surface.	1 prism.	2 p.	3 p.	4 p.	5 p.	10 p.
Deviation $i-\frac{\alpha}{2}$	1·5	12° 32′	25° 4′	50° 8′	75° 12′	100° 16′	125° 20′	250° 40′
	1·6	15° 15′	30° 30′	61° 0′	91° 30′	122° 0′	152° 30′	305° 0′
	1·7	18° 5′	36° 10′	72° 20′	108° 30′	144° 40′	180° 50′	361° 40′
Dispersion $\frac{\sin\frac{\alpha}{2}}{\cos i}$	1·5	·467	·935	1·870	2·804	3.739	4·674	9·348
	1·6	·484	·968	1·936	2·904	3·872	4.840	9·680
	1·7	·504	1·008	2·016	3·023	4·031	5·039	10·078
Transmitted $\frac{1}{2}[(1-A')^m+(1-B')^m]$	1·5	·957	·916	·841	·774	·724	.661	·461
	1·6	·943	·892	·799	·719	·651	·592	·391
	1·7	·926	·859	·745	·653	·578	·516	·324

TABLE II.—60° *Prisms.*

		1 surface.	1 prism.	2 p.	3 p.	4 p.	5 p.	10 p.
Deviation	1·5	18° 35′	37° 10′	74° 20′	111° 30′	148° 40′	185° 50′	371° 40′
	1·6	23° 8′	46° 16′	92° 32′	138° 48′	185° 4′	231° 20′	462° 40′
	1·7	28° 13′	56° 26′	112° 52′	169° 24′	225° 44′	282° 10′	564° 20′
Dispersion	1·5	·756	1·512	3·023	4.535	6·046	7·558	15·116
	1·6	·833	1·667	3·334	5·000	6·667	8·334	16·668
	1·7	·949	1·899	3·797	5·696	7·594	9·493	18·986
Transmitted	1·5	·945	·895	·811	·742	·686	·641	·509
	1·6	·920	·853	·748	·672	·618	·578	·491
	1·7	·888	·801	·681	·608	·565	·538	·505

TABLE III.—*Angles of Prisms* 67° 22′, 64° *and* 60° 56′.

Deviation	1·5	22° 38′	45° 16′	90° 32′	135° 48′	181° 4′	226° 20′	452° 40′
	1·6	26°	52°	104°	156°	208°	260°	520°
	1·7	29° 4′	58° 8′	116° 16′	174° 24′	232° 32′	290° 40′	580° 20′
Dispersion	1·5							
	1·6	1.	2.	4.	6.	8.	10.	20.
	1·7							
Transmitted	1·5	·923	·863	·763	·691	·639	·600	·520
	1·6	·899	·818	·702	·629	·582	·552	·505
	1·7	·874	·780	·657	·588	·549	·523	·501

Table I applies to prisms of 45°. Table II to those of 60°, these being the forms in general use, and Table III. where the angle is such that the reflected light would be totally polarized, α being 67° 22′, 64°, and 60° 56′ in the three cases respectively. This form of prism appears to present great advantages for large spectroscopes, since at most but one half of the light can be reflected, while one prism disperses as much as two of 45°.

To apply these tables to an example, let us compare three spectroscopes of ten prisms each of angles 45°, 60° and 64°, the index of refraction being 1·6.

10 prisms of	Deviation.	Dispersion.	Transmitted.	Trans $\times \cos i$.
45°	305° 0′	9·680	·3911	·308
60°	462° 40′	16·668	·4912	·294
64°	520°	20·000	·505	·268

Again, comparing spectroscopes producing equal deviation,

	Deviation.	Dispersion.	Transmitted.	Trans. $\times \cos i$.
12 prisms of 45°	366°	11·616	·339	·268
8 " " 60°	370° 8′	13·334	·532	·319
7 " " 64°	364°	14.	·521	·276

From the first example we see that by using 64° prisms instead of 45° we obtain more than double the dispersion, with even less loss of light, while in the second case seven 64° prisms prove much more efficient than twelve of 45°.

All these calculations seem to point to the superiority of

60° prisms, over those of 45°. A much greater angle is objectionable from the increased distortion produced by the slightest imperfection in the refracting faces.

In prisms admitting the same amount of light the more acute the angle, the less is the quantity of glass and the less the area of each face. The ground might be taken that a 45° prism could be made larger than one of 60° at the same expense, and thus the difference in light remedied. In this case, however, it would be necessary to enlarge the telescope, number of prisms, and in fact the whole instrument. Even supposing this change made, the prisms of larger angle preserve their superiority, though not in so marked a degree. The calculation is readily made by multiplying the transmitted light by cos *i*, as is done in the above examples.

The index of refraction varying with the refrangibility of the rays, the dispersion, loss of light, &c., would vary in different parts of the spectrum. The change would, however, be small, and could be determined, if necessary, by merely altering *n*.

Institute of Technology, Boston, Feb. 29th, 1868.

ART. XXXIII.—*Contributions to Mineralogy.*—No. VII; by F. A. GENTH.

DURING the last year or two, I have been engaged with the investigation of several very rare minerals, the composition of which was but little known, or doubtful, principally from localities on the Pacific coast.

In some instances, the results which have been obtained, although sufficient to establish with great probability the true nature of the species, represented, on account of the great scarcity of material, the composition of mixtures of several minerals. As for instance with the California tellurids, of which I have for a long time in vain endeavored to procure larger quantities of pure material, but despairing to find any, I had already written out my results for publication, when about two months ago, through the kindness of several friends, I was so fortunate as to obtain of these interesting minerals, minute, but *perfectly pure* fragments, which enabled me to renew my examinations and in this manner partly to correct results, which had previously been obtained, and also to establish an interesting *new* species. I will now proceed with the results of my investigation.

1. *Whitneyite.*—About three years ago a specimen of this mineral was brought to the Hon. N. S. Higgins, then at the

Cerro Colorado mine, Southern Arizona, under the impression that it contained a large amount of silver, and he was requested to ascertain the value of the ore. To the great disappointment of the owner he recognized it as an arsenid of copper, and found in a pure fragment of it, 11·59 per cent of arsenic, which proved that it was Whitneyite. He secured the specimen, which he kindly presented to me.

In its crystalline structure and color, it has exactly the appearance of specimens, furnished by the original locality, the Pewabic mine, Michigan. It is somewhat intermixed with a hornstone-like mineral. The analysis gave, after deducting 9·52 per cent of hornstone, etc.:

Copper,	88·54	per cent.
Silver,	*a trace*	
Arsenic,	11·46	"

From La Lagoona, a rancho on the road to Libertad, about 35 miles from Saric, Sonora, where it is said to exist in considerable quantities.

2. *American Tellurium minerals.*—The first discovery of a tellurid in this country is due to Dr. C. T. Jackson (this Journ. [II], vi, 188), who from some preliminary examinations supposed that from the Whitehall mine, Spotsylvania Co., Va., which had been mistaken for molydenite, to be *foliated tellurium.*

A short time afterward a mineral was discovered at a gold mine in Fluvanna Co., Va., which much resembled that from the Whitehall mine. It was analyzed by Mr. Coleman Fisher, Jr. (this Journ. [II], vii, 282), who recognized it as a "*telluret of bismuth,*" containing a *large percentage of selenium.*

In a subsequent publication (this Journ. [II], x, 78), Dr. Jackson corrects his first statement and gives the result of an analysis, showing the Whitehall mineral to be *tetradymite* and *not* foliated tellurium.

In his paper he also observed the occurrence of *yellow oxyd of bismuth,* investing the nodules of the tellurium ore, which is *not* carbonate of bismuth, for it does not effervesce with acids.

In the year 1850, I discovered *tetradymite* in Davidson Co., N. C., of which I published a description and analysis (this Journ. [II], xvi, 81). I mention as associated with it a mineral, resulting from its oxydation, containing *telluric acid.*

In my Contributions to Mineralogy (this Journ. [II], xix, 15), I show that the mineral from Fluvanna Co., Va., analyzed by Mr. Coleman Fisher, Jr., contains *no* appreciable quantity *of selenium* but is a *pure tertellurid of bismuth.*

As new localities of tetradymite I mention the Phoenix mine and Boger mine, Cabarrus Co., N. C.

Several localities at which tetradymite was found, were given by Prof. C. U. Shepard, one in the Chestatee river near Dahlonega, Lumpkin Co., Ga., then the Pascoe mine, Cherokee Co., and another near Van Wort in Polk Co., Ga. (this Journ. [II], xxvii, 39).

The discovery of *bornite* at Field's gold mine, near Dahlonega, Ga., was announced by Dr. Jackson ([II], xxvii, 366). This I proved subsequently to be erroneous (Mining Magazine, [II], i, 358), showing the mineral, like that from Fluvanna Co., Va., to be *tertellurid of bismuth*, which opinion was fully corroborated by a reëxamination of the same mineral by Mr. David M. Balch, (this Journ. [II], xxxv, 99).

These are, as far as I can ascertain, all the localities at which tellurium minerals have been found in the Atlantic States, and they represent only the *one* species, tetradymite, but in its *two* well established varieties.*

The Pacific States have lately furnished a far greater variety and in fact, with the exception of *sylvanite*, all the known tellurium minerals have been found there, together with several *new* ones.

Prof. W. P. Blake was the first who reported the occurrence of tellurium ores in California (Geological Reconnoissance in California, 302) (this Journ. [II], xxiii, 270), stating that a mineral containing tellurium and silver, probably hessite, had been washed out from a gold drift near Georgetown, Eldorado Co., Cal.

The next information which was published about California tellurium ores, is contained in a pamphlet on the "New Melones Gold and Silver Mines," in which appears a Report of Mr. Charles A. Stetefeldt on the Reduction of Telluric Gold and Silver Ores, an abstract of which was published in the Berg. und Hüttenmännische Zeitung, Oct. 30, 1865. Stetefeldt remarks that "*the samples of ore from the Stanislaus mine contain large quantities of sylvanite or graphite tellurium of steel-gray color and metallic luster, by far the richest tellurium ore, and smaller quantities of the tellurium of lead, recognizable by its tin-white color and great luster.*"

Mr. Guido Küstel describes in the Mining and Scientific Press of San Francisco, of May 20th, 1865, the principal ore of the Melones mine, "tellurite (!) of silver-gold as a new species, gives its specific gravity as from 9 to 9·4 and the composition, determined by blowpipe analysis as follows: Au=24·80, Ag=40·60, Te=35·40 (?). In a communication dated San Francisco, Jan. 4, 1866 (Berg. und Hüttenmännische Zeitung, 1866, 128), he states that he has neither observed sylvanite nor tellurid of lead, but besides the principal ore, of which he gives his previous results (misprinted 21·80 instead of 24·80), tellurid of silver, native tellurium, copper-nickel (!? Genth) pyrites and free gold.

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* In Dana's System of Mineralogy, ii, 64, it is mentioned that minute crystals, which I had observed to occur with gold ores at Gold Hill, Rowan Co., N. C., were probably *sylvanite*; subsequent examination, however, proved them to be *bismuthine*.

Mr. Jas. Ross Browne in his Report on the Mineral Resources of the States and Territories West of the Rocky Mountains, Washington, 1867, published W. P. Blake's catalogue of March, 1866, in which the latter states that at the Stanislaus and Melones mines, "*very beautiful specimens of gold associated with tellurium were taken out of a vein from* 6 *to* 18 *inches thick, and at a depth of* 200 *feet from the surface. This telluret has a tin-white color and is not foliated like the tetradymite of the Field vein in Georgia. Its exact specific character is not yet determined.*"

At the meeting of the Academy of Nat. Sciences in Philadelphia, of August 6th, 1867, I have made some observations referring to the progress of my investigations, and announced the occurrence of a new mineral, tellurid of nickel, at the Melones mine.

In a private communication, dated Helena, Montana Territory, Nov. 25, 1867, Mr. J. L. Kleinschmidt informs me, that about two months previously, he had received from Prof. Swallow a mineral of the appearance of bismuth, which attracted his attention by its pale gray color and bright luster. A preliminary examination gave lead, silver, gold and tellurium. No further examination having been made, nothing can be said as to its true nature.

Prof. B. Silliman mentioned at the session of Dec. 2, 1867, of the California Acad. of Sciences, the occurrence of tellurium ores at *three new* localities—at the Golden Rule mine on the mother lode near Poverty Hill, Tuolumne Co., where ores similar to those of the Melones mine are found in thread-like quartz veins, crossing the cleavage of argillite, at the Raw Hide rancho mine and at the Reist mine on the mother lode at Whisky Hill, Tuolumne Co., where he discovered a very small crystal of hessite. In one of the mines at Angel's camp he observed foliated tellurium.

On the 5th of Dec. 1867, Mr. Kleinschmidt writes me from Helena, that he had discovered in placer gold from Highland, Montana Territory, gray metallic scales which he found to contain tellurium and bismuth. He very liberally placed the whole quantity which he had secured, into my hands for further investigation.

This brief review contains, I believe, all that has been communicated with reference to the occurrence and composition of tellurium minerals in this country, and it will be seen from it that very much doubt existed as to the real nature of the California minerals. I was very anxious therefore, to submit them to a thorough chemical examination.

To Dr. Theodore F. Moss, I am indebted for the first two pieces from the Stanislaus mine, Calaveras Co., Cal., which I have received, and which have furnished very important material for this investigation, one containing the tellurid of nickel (melonite), in the purest condition, in which I have seen it, only very little mixed with hessite, and the other, principally hessite, but mixed with more or less melonite.

The next and also very valuable specimen from the Stanislaus mine, was brought from California by the Hon. N. S. Higgins. It contained the tin-white altaite, in some portions so intimately mixed with hessite that, before I had obtained a pure specimen of altaite, I thought it might be a new species. It also contained foliated melonite, and minute specks of a mineral, which may be native tellurium.

My analyses had to be made with the cleanest that could b selected from the very much mixed material of these three pieces, but they were at once, as far as possible, repeated, when I received through the kindness of Dr. I. Adelberg and Messrs. Louis Beckers and Jas. B. Hodgkin of New York, and E. Balbach, Sr., of Newark, N. J., specimens from the Stanislaus mine, which gave me minute quantities of perfectly pure altaite, the highly auriferous hessite (petzite), and of the new and interesting mineral calaverite.

The tellurium ores of the Stanislaus mine occur in talcose and chloritic slates, associated with quartz, dolomite, ? apatite, a uranium mineral, titaniferous iron, pyrites, chalcopyrite, small quantities of galena, blende, and free gold. In the specimens which I have seen, neither of these mineral forms in the quartz or dolomite larger patches; they are generally present in small particles only, and so much mixed together, that but two pieces furnished the pure material, which I could obtain for examination.

I had just finished my investigation of the tellurids from the Stanislaus mine, when I received for examination, through the kindness of Professors B. Silliman, Dana and Brush, a specimen of petzite from the Golden Rule mine, Tuolumne Co., Cal. It is associated with minute quantities of altaite, gold and pyrites, with quartz and dolomite in argillaceous slate. The specimen furnished perfectly pure material for analysis.

a. Petzite and Hessite.—Of all the tellurium minerals, which *have been observed in* California, that variety of tellurid of silver, in which a large portion of silver is replaced by gold, the so-called petzite, appears to be the most common.

The specimens which I have examined, both from the Stanislaus mine and from the Golden Rule mine, were without crystalline structure, showed a distinct conchoidal fracture, metallic luster and a color between dark steel gray and iron black, sometimes tarnished with pavonine colors. Brittle, soft, hardness about 2·5, sp. gr. according to Küstel 9—9·4. Streak, iron black.

B.B. with soda gives a bluish green flame and yields a silver globule of a yellowish white color. If a fragment is placed upon a hot coin, or is very cautiously heated with the blowpipe, the dark steel-gray color changes into a dull yellow, from the separation of gold globules, as observed by Küstel. Nitric acid turns it black at once, and dissolves it slowly with the separation of metallic gold; aqua regia dissolves it with the separation of chlorid of silver.

The material for the analyses, highly magnified, was found to be free from admixtures with the exception of a minute quantity of quartz, which was deducted as follows: from analysis I, 2·60 p. c., from II, 0·99 p. c., from IV, 0·48 p. c., and from V, 0·59 p. c.

	Stanislaus Mine.			Golden Rule Mine.	
	I.	II.	III. (Küstel).	IV.	V.
Gold,	25·55	25·70	24·80	25·60	24·97
Silver,	41·93	42·36	40·60	41·86	40·87
Tellurium,	32·52*	31·94*	35·40 ?	32·68	34·16*
	100·00	100·00	100·80	100·14	100·00

These analyses correspond closely with the composition, expressed by the formula: AuTe+3AgTe, which requires:

Au,	197	25·35
3Ag,	324	41·70
4Te,	256	32·95
	777	100·00

This variety of auriferous tellurid of silver is closely allied to that from Nagy-Ag, analyzed by Petz, but it contains a considerably higher percentage of gold. The analysis of Petz agrees nearly with the formula 2AuTe+9AgTe, the ratio between Au : Ag being 1 : 4·7, whilst that of the California mineral is 1 : 3.

Notwithstanding this difference in composition, they should *not* be considered as different species, gold being capable of replacing silver in variable quantities, I adopt therefore, Haidinger's name "Petzite," for *all varieties* of telluric silver, in which a large portion of silver is replaced by gold.

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* From the loss.

Not all the tellurid of silver from the Stanislaus mine, howver, is petzite; there occurs also the other variety, which does ot contain any, or only a very small percentage of gold, as lready observed by Küstel.

The *true* hessite, or the variety more approaching to it, is of darker color and seems not to form larger particles, but to be ore finely disseminated through the matrix, often between the leavage planes of dolomite.

I have not been able to obtain it for my analyses in a state f purity. It was mixed with other tellurids, with quartz, olomite and free gold. For the purpose of analyzing it, the ixed material, coarsely powdered, was treated with warm dilute chlorhydric acid to remove the dolomite, then picked out gain, after having been thoroughly washed, but it was impossible to obtain it free from quartz, tellurid of nickel and free gold.

It was necessary, therefore, for the purpose of ascertaining the condition in which the gold was present, whether as tellurid or free gold, to make a careful analysis of the free gold associated with the Stanislaus mine tellurids, and from the amount of silver remaining with the gold, after treating the mineral with nitric acid, both the amount of free gold and that of tellurid of gold was determined. The free gold contains:

Gold,	88·63	per cent.
Silver,	11·37	"
	100·00	

The purest hessite (I), after deducting 7·21 p. c. of admixtures, of which 4·22 p.c. were of free gold and the balance quartz, and a less pure specimen (II), which contained 28·60 p. c. of admixtures, of which 6 p. c. were of free gold, gave:

	I.	Requires Te.	II.	Requires Te.	
Gold,	3·28	1·06	3·22	1·05	for AuTe
Silver,	46·34	27·45	55·60	32·95	" AgTe
Lead,	1·65	1·02	----	----	" PbTe
Nickel,	4·71	15·32	1·54	5·01	" Ni_2Te_3
Tellurium,	44·45		39·64*		
	100·43	44·85	100·00	39·01	

This would be equal to:

	I.	II.
Hessite,	78·11	92·82
Altaite,	2·67	----
Melonite,	20·03	6·55

Ratio of Au : Ag in the hessite in I=1 : 25; in II=1 : 31.

There certainly exists also the variety of hessite, which is *entirely free* from gold; that which was mixed with the impure altaite, III, and with the melonite (see below), did not contain any, and the material for analysis when dissolved in nitric acid, did not separate any brown gold, it contained, therefore, the *true* hessite.

b. Altaite.—This very rare mineral also occurs at the Stanislaus mine as already observed by Charles A. Stetefeldt, and it appears to be the mineral to which W. P. Blake refers in his catalogue. I noticed it in minute quantities with the petzite from the Golden Rule mine.

It is easily distinguished from the other tellurids by its tin-white color, which has a slight but distinct greenish yellow hue. Tarnishes with a bronze yellow color. Cleavage distinctly, in some pieces eminently cubical. Exceedingly brilliant metallic luster. Hardness below 3. Streak gray.

Analysis I was made with an almost pure piece; after deducting 1·03 p. c. of quartz, and 1·96 p. c. for II, which was less pure, I obtained:

	I.	Requires Te.	II.	Requires Te.
Lead,	60·71	37·54	47·84	29·58
Silver,	1·17	0·69	11·30	6·70
Gold,	0·26	0·08	3·86	1·25
Tellurium,	37·31		37·00*	
	99·45	38·31	100·00	37·53

These analyses would represent the composition of the two specimens as:

Altaite,	99·25	77·42
Hessite,	2·20	23·11

Before I had the purer varieties of altaite, from which the two last analyses were made, I analyzed some from the piece presented by Mr. Higgins. It gave results which were, in several points of view, of interest. After, from the purest that could be found, the carbonates had been removed by dilute chlorhydric acid and it had been completely washed, it was pulverized and the lighter portion washed off. The heavier portion gave after deducting 8·00 p. c. of free gold and 3·45 p. c. of quartz:

(Mixture of altaite and hessite) III.

Silver,	44·49	requiring Te	26·36
Lead,	18·37	" "	10·89
Tellurium,	37·14*		
			37·25

This mixture contains, therefore, 70·85 p. c. of *true* hessite and 29·26 p. c. of altaite.

This result was quite surprising, since the material appeared to be comparatively pure, at any rate seemed to contain a far *larger* percentage of altaite.

Future investigations will be necessary to ascertain whether there really exists a tellurid of silver, or tellurid of silver and ead, which has the white color and cubical cleavage of the altaite.

c. ? Native tellurium.—I have above already mentioned, that he specimen brought by Mr. Higgins contained minute specks of a mineral which may be native tellurium. The quantity which I have observed is microscopic. They have a grayish-white color.

According to Küstel, native tellurium occurs at the Stanisaus mine. That these greyish-white specks might be native tellurium has been suggested by the results of the analysis of the light washings from the last mentioned analysis. They contained 94·23 p. c. of quartz and other insoluble substances, but no gold, and 5·77 p. c. of tellurium minerals, showing the following composition:

Ag,	30·75	requiring Te	18·23	=48·98	p. c.	*true* hessite
Pb,	26·94		16·66	=43·60	"	altaite.
Te,	42·31			7·42	"	tellurium.
	100·00		34·89			

This leaves an excess of 7·42 p. c. of tellurium, which may be present in the native state. This becomes the more probable, if we take into consideration the far lower specific gravity of this substance. The analysis of melonite also gives a slight excess of tellurium, which may be due to an admixture of the native metal.

d. Melonite.—A new mineral, Ni_2Te_3(?), hexagonal. I observed one microscopic, but perfect six-sided plate; generally in indistinct granular and foliated particles, with eminent basal cleavage. Luster metallic, color reddish-white, similar to that of bismuth, tarnishes rarely, with a brownish color. Streak, dark gray. B.B. in a tube gives a sublimate fusible into colorless drops, leaving a gray mass; on charcoal, it burns with a bluish flame giving very little white volatile incrustations and eaving a grayish-green residue, which in the inner flame with soda yields a gray magnetic powder of metallic nickel. Dissolves in nitric acid with a green color, yields on evaporation a white crystalline powder of tellurous acid ; addition of ammonia gives a clear blue solution.

This appears to be one of the rarest of the tellurids of the Stanislaus mine. Only one of the specimens which I have received contained enough of the mineral to make an analysis of it, and this was mixed with quartz, and small quantities of hessite, altaite and possibly of native tellurium. After deducting 22·22 p. c. of quartz and 3·26 p. c. of free gold, I obtained:

		Requires Te.		
Silver	4·08	2·42	6·50	p. c. of *true* hessite.
Lead	0·72	0·45	1·17	" altaite.
Nickel	20·98	68·27	89·25	" melonite.
Tellurium	73·43		2·29	" nat. tellurium.(?)
	99·21	71·14		

The nickel from all my analyses contained just enough cobalt to color a borax bead very slightly blue.

From this analysis as well as from the two analyses of hessite given above, the formula of the melonite appears to be Ni_3Te_3. Although the hexagonal form would better agree with the formula NiTe and bring the melonite into the same group with millerite, pyrrhotine, greenockite, etc., it is not very probable that it is a mixture of native tellurium and NiTe, because it would have contained about one third of native tellurium. The material for analysis, however, strongly magnified showed distinctly a small quantity of the dark colored hessite, and every other particle showed the reddish hue, but *not the slightest* admixture of a greyish white mineral could be observed.

The composition of melonite, corresponding with Ni_2Te_3 would be:

2Ni	59	=	23·51
3Te	192		76·49
	251		100·00

e. Calaverite, a new mineral, $AuTe_4$.—I have only observed it once, associated with petzite, on a specimen from the Stanislaus Mine.

Massive, without crystalline structure. Soft. H. below 3. Brittle. Luster metallic. Color bronze yellow. Streak yellowish gray. Fracture uneven, inclining to subconchoidal.

B.B. on charcoal burns with a bluish green flame and yields globules of gold of a *high* yellow color. Nitric acid darkens it and separates metallic gold; aqua regia dissolves it with the separation of a minute quantity of chlorid of silver. The material for the analyses when strongly magnified appeared to be perfectly pure. In II, 1·45 pr. ct. of quartz were deducted.

	I.	II.
Gold	40·70	40·92
Silver	3·52	3·08
Tellurium	55·89	56·00*
	100·11	100·00

Associated and frequently mixed with the calaverite is *petzite.* Although the material for analyses appeared perfectly pure, from an admixture of petzite probably results the greater portion of the silver, but a minute quantity is certainly replacing a portion of the gold, because, if the whole amount of silver with the corresponding quantity of gold (41·70 : 25·35) is taken as petzite, both analyses would give only about 97 pr. ct. The ratio between gold and tellurium (after deducting the silver as petzite) is 1 : 4·2 or nearly 1 : 4, the most probable formula for calaverite is therfore $AuTe_4$, which in its pure state would have the composition :

Au	197	44·47
4Te	256	55·53

A comparison between the analyses of the calaverite and those of the Transylvania sylvanite leads to very interesting suggestions. Under the name sylvanite, *two* distinct minerals are generally treated; one, the so-called "graphic tellurium," for which the name "sylvanite" may remain, and the "weisstellur" and "gelberz."

The most recent and reliable analyses of these minerals were made by Petz, who found in the graphic tellurium from Offenbanya :

	I.	II.
Tellurium	59·97*	58·81*
Antimony	0·58	0·66
Gold	26·97	26·47
Silver	11·47	11·31
Copper	0·76	----
Lead	0·25	2·75

Of the varieties weisstellur and gelberz from Nagy-Ag, he analyzed : I, long crystals of a white color; II, thick crystals ; III, short yellowish crystals; IV and V, massive bronze-yellow mineral :

	I.	II.	III.	IV.	V.
Tellurium	55·39	48·40	51·52	44·54	49·96
Antimony	2·50	8·42	5·75	8·54	3·82
Gold	24·89	28·98	27·10	25·31	29·62
Silver	14·68	10·69	7·47	10·40	2·78
Lead	2·54	3·51	8·16	11·21	13·82

From these analyses it will be observed that in the graphic tellurium the amount of silver varies but very little,. and that the analyses of Petz give exactly, what Berzelius, and a trifle more, than what Klaproth had already found. On the contrary the analyses of the weisstellur and gelberz show the greatest possible variation in all their constituents. Including Klaproth's analysis, the antimony varies from *none* to 8·54 p. c., the silver from 2·78 to 14·68 p. c., and the lead from 2·54 to 19·50 *p. c.*

The most rational conclusion under these circumstances is to consider these minerals mechanical mixtures of different species, such as native antimony, altaite and hessite, with a peculiar tellurid of gold.

Starting from this supposition, I found, after deducting the admixtures, the ratio of gold and the remaining tellurium as follows:

In	I,	=	1 : 4·95
"	II,	"	1 : 4·24
"	III,	"	1 : 4·78
"	IV,	"	1 : 3·82
"	V,	"	1 : 4·13

The two last analyses, those of the *massive bronze yellow* mineral, seem to prove that "gelberz" is nothing else than an *impure* calaverite.

The analyses of the graphic tellurium, for which the formula $Ag Te_3+AuTe_3$ has been given, correspond better with the formula $AgTe_4+AuTe_4$, especially, if the *exact* ratio between gold and silver, which has been *found*, is taken as the basis of the calculation. Ratio of Au : Ag in I=1 : 0·84, in II=1 : 0·8. The latter would give the following composition, which agrees very well with the analysis:

Au	197·0	26·47
0·8Ag	86·4	11·61
7·2Te	460·8	61·92
	744·2	100·00

The white color of the weisstellur, together with the higher percentage of tellurium show that they are intermediate varieties, in which more or less silver is present as $Ag Te_4$ replacing a portion of the gold.

The relation existing between sylvanite and calaverite is similar to that between petzite and hessite.

In connection with the tellurids of the Stanislaus mine and the new localities discovered by Prof. B. Silliman, I will mention that a specimen of gold in quartz from the Grass Valley, Cal., for which I am indebted to Dr. Lewis Feuchtwanger, contains minute quantities of a lead colored mineral, which contains tellurium, silver and a small quantity of lead, surrounding the gold. The quantity was too small for further examination.

f. Tetradymite.—I have examined two varieties of tetradymite, one found in placer gold at Highland, Montana Terr., by Mr. Kleinschmidt (I), and the other from the Phœnix Mine, Cabarrus Co., N. C. (II). I. The Montana mineral occurs in scales. The largest of those which I received was about $\frac{1}{6}$ of an inch in diameter and about $\frac{1}{16}$ of an inch in thickness. Some of the scales showed the lateral planes of a six-sided prism. Color between lead and steel grey. It was partly oxydized into a substance, which proved to be a new mineral, a tellurate of bismuth, for which I propose the name "*Montanite.*"

For the analysis, both of the tetradymite and montanite, a weighed quantity of the mixed minerals was treated with dilute warm chlorhydric acid, which leaves the tetradymite unacted upon, whilst the montanite is easily dissolved by it. The specimen was found to contain:

Tetradymite	49·23
Montanite	50·77
	100.00

II. The tetradymite from the Phœnix mine, of which I never have seen more than the one specimen in my collection, occurs in very minute scales, the largest not being over $\frac{1}{32}$ of an inch in width, of a color between lead-grey and iron-black implanted and disseminated in quartz and associated with free gold and pyrites. From the analysis was deducted 86·71 p. c. of quartz and free gold.

The following results were obtained:

	I (Montana.)		II (Phœnix Mine).	
Quartz,	0·78	Copper,	0·41	p. c.
Ferric oxyd,	0·90	Iron,	0·54	requires 0·61 sulphur.
Bismuth,	50·43		57·70	
Tellurium,	47·90		36·28	
Sulphur,	none		5·01	
	100·01		99·94	

The ratio between bismuth and tellurium in I. is very near =1 : 3, which places this tetradymite alongside of those from Fluvanna Co., Va., and Field's mine, Georgia.

In analysis II. is a slight admixture of pyrites. The requisite quantity of sulphur for the amount of iron found, is=0·61, leaving 4·40 p. c. of sulphur as a constituent of the tetradymite. The ratio between sulphur, tellurium and bismuth is =1 : 2·03 : 1, giving exactly the formula $BiS_3+2BiTe_3$.

Admitting with Gustav Rose that tellurium sometimes replaces bismuth, as in the native bismuth from the Sorato, the bismuthine from Riddarhyttan, and the mineral from Cumberland, England, analyzed by Rammelsberg, which contains 6·43 p. c. of sulphur, equal to 28·13 p. c. of BiS_3, showing it to be a *mixture of bismuthine and native bismuth*, the tetradymites certainly should not be placed under native bismuth and considered as varieties of this mineral. It is far more rational to suppose that both sulphur and tellurium first satisfy their chemical affinities, if coming in contact with bismuth. If we reject Jackson's analysis, which is deficient in sulphur, and Wehrle's of the so-called "Molybdän-silver" from Deutsch-Pilsen, which shows a loss of nearly 5 p. c. and an admixture of over 2 p. c. of silver, all the other analyses prove that tetradymites form beyond doubt *two distinct* and *definite* compounds, those from Fluvanna Co., Va., and the Field's mine, Ga., like that from Montana Territory, being $BiTe_3$, whilst those from Schubkau in Hungary, Davidson Co., N. C., and the Phœnix mine, Cabarrus Co., N. C., are unquestionably $BiS_3+2BiTe_3$.

The bornite from San José, Brazil, requires reëxamination, before its true nature can be established.

g. Montanite, a new mineral, BiO_3TeO_3HO (or 2HO).—Results from the oxydation of tetradymite. I first distinguished it as a *new* mineral in the examination of the Montana tetradymite and named it after the territory. Having found it to be a new mineral and a very interesting one, on account of being the *first tellurate* observed in nature, I looked over my paper on the Davidson Co., N. C. tetradymite (this Journ. [II], xvi, 81), where I found that I stated that the oxydized portion "*evolved chlorine, when treated with chlorhydric acid and that therefore some of the tellurium was oxydized into telluric acid.*" Deeming a fuller investigation of much interest, I analyzed it and found beyond doubt, although my material was not quite pure, that the North Carolina mineral is *identical* with montanite. There was no tellurous acid present.

It is very probable that the "*yellow oxyd of bismuth*" from the Whitehall mine, Va., observed by Dr. Jackson (this Journ., [II], x, 78), is the same mineral.

Not crystallized, but some portions still retaining the scaly structure of the origial tetradymite, and being in reality pseudomorphous after it (N. C.). Earthy incrustations. Color yellowish, greenish and reddish white; luster waxy to dull. H. about 3. Brittle.

B. B. reactions of bismuth and tellurium. Yields water, when heated in a tube. Gives off chlorine, when heated with strong chlorhydric acid, dissolves easily in dilute chlorhydric acid. Sulphydric acid precipitates from this solution only bismuth, lead and copper, but *no* tellurium, after neutralizing the filtrate by ammonia and the addition of a sufficient quantity of sulphid of ammonium, the whole quantity of tellurium can be precipitated by dilute chlorhydric or sulphuric acid as black tersulphid. The analysis gave:

	I.		II.		III.	
	From Montana.		From Davidson Co., N. C.			
		O.		O.		O.
Ferric oxyd,	0·56	----	1·26	----	0·32	----
Plumbic "	0·39	----	----	----	----	----
Cupric "	----	----	1·04	----	1·08	----
Bismuthic oxyd,	66·78	6·85	68·78	6·92	71·90	7·37
Telluric acid.	26·83	7·30	25·45	7·05	23·90	6·51
Water,*	5·94		3·47		2·80	
	100·00		100·00		100·00	

The oxygen ratio between teroxyd of bismuth and telluric acid is very near equal to 1 : 1. Some doubt remains, however, to the amount of water, and future investigations have to ascertain whether it contains one or two equivalents. The composition of the pure mineral would be either of the following:

		BiO_3, TeO_3+HO			BiO_3, TeO_3+2HO
BiO_3	234	70·69	BiO_3	234	68·82
TeO_3	88	26·60	TeO_3	88	25·88
HO	9	2·71	$2HO$	18	5·30
	331	100·00		340	100·00

3. *Barnhardtite* from Arizona.—I have observed this mineral amongst the copper ores of Bill Williams Fork, Arizona, associated with metallic copper, cuprite, copper glance, chalcopyrite, pyrites, chrysocolla, malachite and brochantite.

An analysis made by Mr. N. S. Higgins gave :

Copper	50·41 p. c.
Iron	20·44
Sulphur	28·96
	99·81

It showed a slight admixture of copperglance.

4. *Cosalite, a new mineral,* $2PbS+BiS_3$.—A small specimen of this very interesting mineral was presented to me by Dr. Theo. L. Moss, who obtained it from a silver mine at Cosala, Province of Sinaloa, Mexico. It occurs disseminated through the whole mass of a pure, white quartz. Only *one* fragment showed a very indistinct crystalline, apparently rhombic form, slender and longitudinally striated. Fracture uneven. Luster metallic. Color lead-gray, soft, brittle. B.B. gives the reactions of sulphur, lead and bismuth, and with soda yields a minute globule of silver.

The only other mineral besides quartz, which I have observed with the cosalite was cobaltine, as ascertained by an arsenic and cobalt-determination of a small fragment. In the analysis the requisite amount of arsenic was therefore calculated for the cobalt found, and after deducting in analysis I, 2·09 p. c. of quartz and in II, 26·83 p. c., the following results were obtained:

	I.	II.
Lead	37·72	33·99
Silver	2·48	2·81
Bismuth	39·06	37.48
Cobalt	2·41	4·22
Arsenic	3·07	5·37
Sulphur	15·59	15·64
	100·33	99·51

The analysis I shows an admixture of 6·79 p. c. of cobaltine, and II of 11·88 p. c. Deducting these quantities the composition is:

	I.	II.
Lead	40·32	38·79
Silver	2·65	3·21
Bismuth	41·76	42·77
Sulphur	15·27	15·23
	100·00	100·00

corresponding closely with the formula $2Pb(Ag)S + BiS_3$, giving the following per centage:

2Pb	207	41·65
Bi	210	42·25
5S	80	16·10
	497	100·00

Cosalite is a Jamesonite, in which the tersulphid of antimony is substituted by tersulphid of bismuth, a small quantity of silver replacing lead.

5. *Boulangerite* from Nevada.—This mineral occurs in the Echo District, Union Co., Nevada, in indistinct long acicular crystals in white quartz. One of the crystals showed prismatic planes similar to those of aragonite. Longitudinally striated. The analysis gave:

Lead	54·82
Silver	trace
Iron	0·42
Antimony	26·85
Sulphur	17·91
	100·00

6. *Tetrahedrite* from Arizona.—An analysis of a "fahlerz"-*like* mineral from the Goodwin mine near Prescott, Arizona,

which I have made, gave, after deducting 4·22 p. c. of quartz, the following result:

Copper,	38·16	requires S for	Cu_2S	9·63	13·78=1·31
Silver,	3·21	“ “	AgS	0·48	
Zinc,	6·23	“ “	ZnS	3·07	
Iron,	1·05	“ “	FeS	0·60	
Arsenic,	trace				
Antimony,	24·67	“ “	SbS_3	9·84	=1
Sulphur,	26·97	“ “			
	100·29			23·62	

The material for analysis appeared to be free from other impurities than quartz, and it is difficult to account for the large excess (3·35 p. c.) of sulphur. The other constituents agree very well with the tetrahedrite formula $4RS+SbS_3$.

Want of material prevented a reëxamination.

7. *Brochantite* from Arizona.—This mineral occurs in minute crystals, on which I could observe the planes *I*, *i̇ĭ* and 1*ĭ*, of a beautiful emerald green color, also in foliated masses at Bill Williams' Fork, Arizona. I analyzed a foliated piece, which, however, was somewhat mixed with chrysocolla and cuprite, and found:

	I.	II.
Water	14·46	----
Chlorine	0·31	0·33
Ferric oxyd	0·33	0·52
Cupric “	67·75	67·69
Sulphuric acid	13·55	13·27
Silicic “	3·60	3·59
	100·00	

This would give:

Brochantite,	$CuO,SO_3+3CuOHO$	76·49 p. c.
Atacamite,	$CuCl+3CuOHO+3HO$	2·10
Chrysocolla, (?)	CuO,SiO_2+4HO	12·68
Limonite,	$2Fe_2O_3+3HO$	0·38
Cuprite,	Cu_2O	7·96
Water,		0·47
		100·08

This is of course to be considered only as an approximation to the composition of this mixture. A more correct calculation could only be made after the composition of the atacamite and chrysocolla from Bill Williams' Fork had been established.

Philadelphia, March 1st, 1868.

ART. XXXIV.—*Remarks on the Geological Formations along the Eastern margins of the Rocky Mountains ;*[*] by F. V. HAYDEN.

ON several former occasions I have described the different geological periods represented by the rocks uplifted along the margins of the Rocky Mountains and especially along the eastern slope. Examinations over a great extent of country in considerable detail, from latitude 49° south nearly to the Arkansas river, have shown me that quite marked lithological and paleontological changes occur in them all as we proceed from the north, southward. It is the purpose of this article to note this fact somewhat more in detail than hitherto. Beginning with the nucleus of the Rocky mountains at any point along the eastern range, we find it composed of massive granite rocks mostly red feldspathic, but not unfrequently gray or other shades of color; then a series of metamorphic rocks (as they are usually called, though no doubt all the granites should be included with them), syenites, diorites, clay, mica and hornblende slates, and igneous rocks of various kinds here and there.

Proceeding outward we find the Silurian period represented by the Potsdam sandstone, Devonian wanting, then Carboniferous, Red beds (Triassic ?), Jurassic, Cretaceous and Tertiary, all connected together in the regular order of sequence, and all but the most recent Tertiary in strict conformity. The Tertiary deposits do not exhibit any marked change either in their mineral or fossil contents from the northern portion of our domain to the Arkansas, but the Cretaceous beds present several quite marked changes. Nos.[†] 5 and 4 maintain their peculiar characters as shown on the Upper Missouri, wherever they are exposed all along the eastern slope, except that they contain comparatively few fossils, yet a few characteristic species are found wherever these beds are seen, which identify them. On the Missouri river, No. 3 attains a great thickness, 400 to 600 feet, presenting massive escarpments of yellow chalk, and it can be traced all the way across the prairie country lying between 98° and 100° longitude. At Forts Hayes and Wallace on the U. P. R. W. E. D., there are massive beds of this chalk which is sawed into building blocks with a common saw, and in many instances it is nearly as white as our chalk of commerce and night be used for the same purposes. The two characteristic pecies of fossils of this division are found everywhere, *Ostrea ongesta* and *Inoceramus problematicus.* All along the slope f the mountains No. 3 still retains its chalky nature but ecomes quite shaly, none of the layers ever becoming more han one or two inches in thickness. This is the case at the ources of the Missouri along the Big Horn and Wind river nountains also, from the South Pass to Pike's Peak, and on the western slope wherever this bed is exposed. Near Denver, at Marshall's coal mine, No. 3 has been changed by heat into a grayish compact limestone, quite hard and brittle in its fracture, which makes an excellent flux in smelting ores. But this hange is local, for 16 miles north of this point it presents the ame laminated character. It seems that No. 3 loses its massive chalky character, by which it first attracted attention on the Missouri river, in its westward extension, so that along the margins of the mountains except in one locality it cannot prove of any economical value, while between 98° and 100° longitude it becomes very useful not only for lime but also for building purposes. No. 2, like Nos. 4 and 5, retains its dark plastic clay character everywhere that it has been observed, but like the others it is not nearly as well developed in Colorado as on the Upper Missouri. Near Fort Benton it attains a thickness of 200 to 400 feet, while in Colorado it is not more than 50 to 150 feet. Between longitude 96° and 99°, No. 1 retains its deep rust-red sandy characters with dicotyledonous leaves, from the Missouri river to the Arkansas, but nowhere along the margins f the mountains from lat. 49° to Pike's Peak have I ever seen ny well defined paleontological proof of its existence. Near ort Benton are a series of Cretaceous beds containing some eams of impure lignite, and numerous species of fossils, not one f which is identical with those so abundant in Nos. 4 and 5 ower down on the Missouri. These beds have been placed rovisionally in the general section as a portion of No. 1, but he region about Fort Benton needs a more careful examination efore any positive conclusions can be arrived at. Around the lack Hills is a bed of massive siliceous rocks, some layers formng a pudding stone which in some localities takes the name of ortification rocks. These hold a position between No. 2 Creaceous and the Jurassic marls. The same are seen along the nargin of the Big Horn mountains, in which I observed a ed of impure lignite, an abundance of silicified wood, and ome uncharacteristic Saurian bones. From the Wind River mountains to Pike's Peak, these same siliceous and pebble cemented rocks occur holding the same geological position, forming, as it were, beds of transition between the Cretaceous and the Jurassic periods. I have carefully examined these rocks for hundreds of miles and have never yet detected any organic remains, animal or vegetable, in them.

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[*] This article refers only to the eastern ranges of the Rocky Mountains, extending south to the Arkansas. The same remarks may or may not apply to other portions.

[†] The different divisions of the Cretaceous period, as shown on the Missouri river, have received geographical names, as Fort Benton group, &c., but I use the old divisions by figures for brevity.

The Jurassic beds, as revealed along the mountains, possess peculiar and marked lithological characters, so that having identified them by the fossils in one locality we can trace them over great areas. They were first shown to exist in the west in the form of a zone engirdling the Black Hills. They here attain a thickness from 200 to 300 feet at least, and from the beds in this locality alone have fossils enough been collected of such unmistakable Jurassic types as to prove their existence beyond a doubt. But these beds have also been shown, since they were first made known in the Black Hills, to be exposed along the margins of the Big Horn and Wind River mountains near Red Buttes, on North Platte and in numerous localities in the Laramie Plains, and westward to Fort Bridger; so numerous are the species now known from the west and so close are the affinities of most of them to well known Jurassic types that it is not necessary for me in this place to detail the evidence in support of that statement.

It is sufficient to remark, that the Jurassic system is quite plainly represented along the margins of the different ranges of mountains north of lat. 42°, but proceeding southward from Deer creek on the North Platte, the Jurassic beds diminish in force until near Cache la Poudre it becomes doubtful whether they are represented at all. At this point there is a thin bed, perhaps 20 to 50 feet in thickness, of greenish gray arenaceous marl overlying the red beds which seem to occupy the place of the Jurassic. This seems to thin out more and more as we proceed southward toward the Arkansas. From Deer creek 100 miles north of Fort Laramie to Denver, a distance of 400 miles, I have searched in vain for any organic remains in the rocks which appear to represent the Jurassic period of the Black Hills, Big Horn and Wind River mountains. In the Red beds or supposed Triassic, no organic remains have been found north of the Arkansas and they do not differ much lithologically in their southward extension except that they seem to be much thicker and more gypsiferous northward. In the far north the Carboniferous rocks are in many localities 500 to 1500 feet in thickness, and even as far south as the Red Buttes the massive beds of limestone with true Carboniferous fossils are exposed 500 to 1000 feet thick and are quite distinct from the red or varigated beds. But as we proceed southward from this point the Carboniferous limestones seem to lose their usual lithological characters and the red beds prevail. At the head of Pole creek on the eastern margin and in the Laramie Plains west, the Carboniferous rocks are mostly of a red arenaceous character, with a few layers 2 to 10 feet in thickness of whitish or yellowish limestone. From these limestones I collected *Productus Prattenianus, Athyris subtilita* and other well known Carboniferous forms. Above these red beds which contain intercalated layers of limestone is a considerable thickness of purely red arenaceous beds, but in studying all these rocks with some care from Pole creek nearly to Pike's Peak, I could not separate the red beds from the Carboniferous by any break in continuity, and I was rather inclined to the opinion that inasmuch as a large portion of the gypsiferous or variegated beds could be shown to be Carboniferous, they might possibly all be included in that period. The Potsdam sandstone, the only portion of the Silurian era ever detected along the eastern slope of the Rocky mountains north of the Arkansas, seems to fade out entirely south of the Red Buttes on the North Platte. It is well defined around the Black Hills, Big Horn and Wind River mountains. Near the Red Buttes there is a bed of siliceous pudding stone resting on the metamorphic rocks which may be the Potsdam in its southern extension, but south of Fort Laramie to Pike's Peak, it is somewhat doubtful whether any trace of it exists. If it occurs at all it is a very thin layer, for the most part concealed. So far as I could determine, the Carboniferous rocks rest directly (though not conforming) upon the metamorphic rocks. There is also some change in the nuclei of the mountain ranges southward. At the north the feldspathic and the gray granites prevail but southward the syenites and igneous rocks form the central portions of the mountains almost entirely. It is rare to see true granite.

The above remarks, founded on observations that have been made over a very great extent of country through a period of many years, lead me to the following conclusions. 1st. That all the formations of the west undergo more or less change both in their mineral and fossil contents in their extension toward the west and south. They all seem to reach their culmination not far from the central portion of the great area drained by the Missouri, and lose to a great extent their distinctive characters beyond its limits.

2nd. The Potsdam sandstone and the Jurassic beds present more remarkable changes than any of the others. While north both these formations are well marked, both lithologically and paleontologically; in their southward extension they gradually fade out so that south of Fort Laramie to Pike's Peak, it becomes a matter of doubt whether they exist at all. The inference therefore is that these groups of rocks are not well defined, if they occur at all south of the Arkansas. In support *of this statement is the fact* that although this southern region has been traversed in every direction by multitudes of explorers for thirty years past, among whom have been geologists of high reputation, yet south of lat. 40° not a single animal fossil has ever been detected with Jurassic affinities, and it is quite doubtful whether any have been found with Triassic or Permian relations,* even the few plants that have been found are doubtful in their affinities and are regarded as probably Cretaceous or Permian. I have made these remarks from the fact that all the observations that have been made by explorers in the west during the past will, ere many years, be put to the rigid test of a most careful scrutiny, and an error by whomsoever made, though sustained by the highest authority in the land, will fall to the ground before the light of true science as the dead bark from a tree. The ease with which the Rocky mountain region can soon be reached in a few years, when our great national highways are completed to the Pacific, will induce the best geologists in this country and in Europe to visit them, and the many intricate problems of Rocky mountain geology must be solved.

The great School of Mines which will no doubt be soon established in the heart of the mining districts of the Rocky mountains, must gather around it able men who will either sustain or reject the observations of other investigators who have examined the country under less favorable auspices.

ART. XXXV.—*Remarks on the possibility of a workable bed of Coal in Nebraska*;† by F. V. HAYDEN.

SUPPLEMENTARY to my article on the lignites of the West, in the March No. of this Journal, I wish to make a few remarks in regard to the existence of workable beds of coal in Nebraska. During the geological survey last season, the greatest interest was felt in this question, by the people, from the fact that nearly all the State is a treeless prairie. Even a bed of coal, of moderate thickness, at a reasonable depth, would be of inestimable value, and the solution of this problem seemed to be the most important one of the survey. It is now known that all the Carboniferous rocks of Nebraska belong to the upper Coal-measures, and that these rocks occupy but a small area in the southeastern portion.

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* I do not wish to be understood as saying that the Jurassic rocks do not occur, south of the Arkansas, as well as the Permian and Triassic, for there is ample room for their fullest development, but no evidence has ever yet been obtained of its (Jurassic) existence, although the country has been so long traversed by explorers. The evidence, so far as it goes, would seem to be against its occurrence at all.

† In the final report of the U. S. Geological Survey of Nebraska, Mr. Meek has discussed the relations of the Carboniferous rocks of Nebraska, with those of the neighboring States, with great minuteness and care. He has, also, made a most extensive comparison of the fossils, from the large amount of material in his possession. He gives in his report numerous tables of fossils, in which he shows clearly what rocks may be regarded as upper Coal-measures, Permo-carboniferous and Permian, with the vertical as well as geographical range of the fossils. He finds no traces of the Dyas or Mountain limestone.

In ascending the Missouri, they pass beneath the water level of the river near DeSoto, about 30 miles above Omaha. The area occupied by them widens southward; but it forms only a narrow strip, hardly two counties wide, even at the south boundary of the State. Overlying the upper Coal-measure rocks, are a series of beds which were called, by Mr. Meek and the writer, Permo-carboniferous, as they occurred in Kansas, a portion of the coal-measure fossils passing up through them, and Permian types passing down. Still holding a higher position, especially in valleys of the Big and Little Blue rivers, are some beds of yellow, soft magnesian limestone which seem to be only a northern extension of what we have regarded as Permian in Kansas. Overlying these are the Cretaceous rocks—especially No. 1 or the Dakota group. There, is, however, no break in the order of sequence of the beds from the Coal-measures to the summit of the Permian.

It is now pretty well proven that in the upper Coal-measures of the West, there are no workable beds of coal, and that, while thin seams occur in many places, they never attain a thickness of more than 2 or 2½ feet. Near Nebraska City, on the Missouri, an outcropping, about 8 inches thick, has attracted some attention. This seam has been wrought by drifting in a distance of 300 yards or more, and several thousand bushels of pretty good coal have been taken from it. At Brownsville, there is a seam of coal probably holding a lower position than the one at Nebraska City, which is accompanied by several species of coal-plants peculiar to the upper Coal-measures, among which Prof. Lesquereux has detected *Neuropteris Loschi*, *N. hirsuta* and *Calamites*.

The seam of coal is from 4 to 6 inches in thickness; but the whole bed of black shale and coal is about 12 inches thick. At Aspinwall, in Nemaha county, two seams of coal were met with. One of them high up in the hills, is probably the same as that just mentioned as occurring at Brownsville, while near the water's edge another seam is disclosed about 22 inches in thickness. Coal commands a ready sale here at 40 to 80 cents per bushel. Some English miners have commenced sinking a shaft, and already cut through the 6 inch seam, expecting in due time to strike the more profitable 22 inch seam.

At Rulo, some 15 or 20 miles below Aspinwall, near the south line of the State, a seam of coal has been wrought for some years. It was about 5 inches thick at the outcrop, but after a drift had been carried into the bank 100 feet or more, it increased to 11 inches, and then nearly disappeared again. About 200 bushels of rather inferior coal have been taken out of this mine; but it does not promise well. On the Iowa Indian reservation, this same bed has been worked, and several hundred bushels of coal taken out, but the mine was soon abandoned.

The seam on the reservation and the one at Rulo is probably identical with the 22 inch seam, revealed 16 feet above the water level of the Missouri river, at Aspinwall. Underneath the coal seam, at Rulo and on the Iowa reserve, is a bed of light gray fire clay, filled with fragments of plants as fern leaves, stems of rushes, Calamites; and among the ferns are *Neuropteris Loschi* Brongt. and *N. hirsuta* Lesq., both common in the upper Coal-measures of Ohio and Kentucky, and the former occurring in the Permian of Europe. Again in Pawnee Co., about 35 miles west of the Missouri, on some of the small branches of the Nemaha river a coal seam crops out which has created some excitement among the settlers.

Again at Tecumseh the county seat of Johnson Co., a thin seam of coal has been opened by a drift and worked with some success. The coal is mostly used by blacksmiths in the vicinity, for there is not sufficient to supply the country with fuel. It is probably the same bed observed south in Pawnee Co., though here the coal seems to be more impure, being made up largely of masses of sulphuret of iron.

I will here quote a paragraph from my preliminary field report of the progress of the Geological Survey of Nebraska, addressed to the Hon. J. S. Wilson, Commissioner General Land Office and printed in his annual report for 1867–8.*

" At Tecumseh a thin seam of coal has been opened, and is now worked with some success by Mr. Beaty. The drift is very similar to that before described in my report of Pawnee Co., and extends into the bank about 100 yards. Mr. Beaty has taken out about 1,000 bushels of coal, which he sells readily at the mine for 25 cents per bushel. It is undoubtedly the same bed that is opened on Turner's branch and at Friez's Mill, in Pawnee county; but is not quite as thick or as good; it contains large masses of the sulphuret of iron and other impurities. The coal seam here varies in thickness from ten to fifteen inches. The cap rock is a bed of limestone not more than two or three feet in thickness. A well was sunk in the village of Tecumseh, sixty feet. A drill was driven down through rock and hard clay a few feet further, and passed through what the workmen thought to be three feet of good coal. This discovery created much excitement at the time and increased the demand for the public lands in Johnson county. It afterward turnéd out to be the same seam of coal worked by Mr. Beaty on the Nemaha and was only 11 inches in thickness. The prospects, therefore, for workable beds of coal in Johnson county are no better than in the neighboring counties, already examined. The evidence against any important bed of coal being found within the *limits* of Nebraska diminishes in force continually. I have already presented a portion of the evidence in former reports. The fact that all efforts in searching for coal in neighboring districts have resulted in failures, renders the prospect very doubtful."

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* See report of Hon. J. S. Wilson, Commissioner of the General Land Office, 1867, pages 124–177.

All the rocks at St. Joseph, Missouri, Leavenworth and Atchison, Kansas, hold a lower position geologically, yet borings have been made about 300 to 500 feet at Atchison and St. Joseph, and a shaft has been sunk about the same depth at Leavenworth, resulting in the discovery of a bed of very impure coal three feet thick, quite unfit for use. The evidence is quite strong that, as I have before suggested, Nebraska is unfortunately located on the western rim of the western coal basin, and that no workable bed will ever be found in the state at a reasonable depth.

I have thus mentioned the different outcroppings of coal in various portions of the state, because their existence seemed to the people to promise better things. The consequence has been that much more money has been spent in the useless search for coal in Nebraska, than the cost of a geological survey for years.

Many excavations and numerous borings have been undertaken without success.

In aid of the solution of the problem whether there are within the limits of the state of Nebraska any workable beds of coal within accessible distance of the surface, the following conclusions are the result of the examination of these rocks during the past season. It has been accurately determined that rocks of the Carboniferous period occupy only a small portion of South Eastern Nebraska, and that these rocks are of the age of the upper Coal-measures, Permo-Carboniferous and Permian.* At Omaha, a boring of nearly 400 feet in depth was made by the U. P. R. R. without passing any important seam of coal. At Nebraska City a boring was made nearly the same distance with the same result.

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* The true Permian may not occur in Nebraska. If it does, it is found only in isolated areas.

At Atchison and Leavenworth, Kansas, and at St. Joseph, Mo., where the upper Coal-measures are several hundred feet lower than at Nebraska City or Omaha, borings were made about 400 feet with no better success.

Mr. Brodhead, a geologist attached to the Missouri State Geological Survey, studied with a great deal of care a series of beds of the upper Coal-measures in northern Missouri which he regarded as 2000 feet in thickness without finding a seam of coal more than 2 or 2½ feet in thickness.

In the valley of the Desmoines river, Iowa, 75 to 100 miles east of the Missouri river, coal beds have been found by Dr. White, State Geologist, varying from 1 to 7 feet in thickness; but the rocks including these beds are regarded by him as the age of the lower Coal-measures. Indeed the upper Coal-measures of the west are regarded as the barren coal-measures, while all the workable beds of coal are confined to the lower Coal-measures. It is plain that all the Carboniferous rocks of Nebraska pass beneath the more recent formations westward to be disclosed again by the uplifting of the Rocky Mountain ranges. We find the Carboniferous limestone all along the margins of the Rocky mountains on either side the axis of elevation. On studying these fossils we find that so many of them are identical with species found in what we know to be the upper Coal-measures along the Missouri, that we do not hesitate to pronounce them as of the same age. Indeed they are simply the western extension of them, thinning out and gradually losing all the thin seams of coal and shale and nearly all the beds of clay and loose sands, leaving for the most part massive beds of limestone.

It is impossible in an article of this kind to present all the details upon which our conclusions are based; but it seems more than probable that coal in paying quantities will never be found within the limits of the state of Nebraska. If this statement is true, it is a very important negative truth not only to Nebraska, but also to very large portions of Iowa, Missouri and Kansas. We already know that the Carboniferous rocks do not exist in Dakota territory at all, so that along the Missouri river there is a very large district of wonderful fertility, almost treeless and destitute of mineral fuel. This fact at once directs our attention to the lignite formations in the region of the Rocky mountains. It is to be hoped that the general government will see the importance of making appropriations for their careful examination at an early day.

ART. XXXVI.—*Character of the Unconformability of the Iowa Coal-measures upon the Older Rocks;* by C. A. WHITE, M.D.*

THE paleozoic rocks of Iowa, with the exception of those of one period, all rest conformably upon each other, and show a regular recession to the southwestward in the direction of their general dip, the trend of their outcrops being quite uniformly in a southeasterly and northwesterly direction. The exceptional unconformability referred to is that of the lower Coal-measures upon the Subcarboniferous rocks, and in connection with the same, the unconformability of some of the members of the Subcarboniferous group upon the others. Succeeding this unconformability, the sub-epochal divisions of the coal measures again show the same gradual recession to the southwestward, together with a similar general direction of trend that the older rocks do.

Thus in the Iowa coal field, we always find the lower Coal-measures at the border; next in order comes the middle when that discrimination has been made,† and then the upper, still farther within the field.

For the purpose of being more clearly understood, the following names and numbers are given in the ascending order, of the numbers of the Subcarboniferous period as at present understood by the writer to be developed in the Mississippi valley.

V. CHESTER LIMESTONE,‡ with its sandstones above and *below*. (Kaskaskia limestone of Prof. Hall.)

IV. St. Louis Limestone. (Concretionary limestone of Dr. Owen, and in part Warsaw limestone of Prof. Hall.)

III. Keokuk Limestone.

II. Lower and Upper Burlington Limestone.

I. Kinderhook beds of Meek and Worthen. (Referred to Chemung group by Hall and others.)

No rocks referable to the Chester limestone epoch have yet been found in Iowa, and wherever the base of the lower Coal-measures is to be observed in that state, they are *usually* found resting, apparently quite conformably, upon the St. Louis limestone. The four first members of the Subcarboniferous period are all well developed in Iowa, particularly in the southeastern part of the state. The Keokuk limestone, however, although in full force in the vicinity of Keokuk, has not been recognized to the northward of the north line of Des Moines county; and the Burlington limestone, although it has astonished the world with the richness of its fauna, loses its distinctive characters within fifty miles to the northward of the city for which it was named, yet the characters of its lower portion appear to remain in connection with the upper part of the Kinderhook beds as far north as Marshall county.

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* In advance of his final report upon the Geology of Iowa.

† Since the writer's communication to this Journal, published July, 1867, the results of further investigations by Mr. St. John and himself in the Iowa coal field during the progress of the State work, seem to warrant the separation of those rocks, which were therein all referred to the lower Coal-measures, into middle and lower, at least in a sub-epochal sense.

‡ Judging from examinations made in Missouri, Kentucky and Southern Illinois, it is not thought that the Ferruginous sandstone of Prof. Hall is properly separable from the epoch of the Chester limestone, but believed that it should be considered as belonging to it, as those similar sandstones do which subdivide that limestone in Kentucky and elsewhere.

It will be seen then that these two members occupy a very limited area within the State, but the St. Louis limestone and Kinderhook beds—the upper and lower members of the group in Iowa—occupy a much larger area than any of the others.

If you draw a line on the map of Iowa, from the southeast corner of Van Buren county, sweeping a little eastward, to the northeast corner of Jefferson county, thence, keeping six or eight miles to the northward of North Skunk river to a point on the south line of Marshall county near its southwest corner, thence to a point two or three miles northeast of Eldora in Hardin county, thence to Webster City in Hamilton county, thence to Fort Dodge in Webster county, you will have approximately the eastern and northern borders of the Iowa coal field, being the thinning-out edge of the lower Coal-measures. Beyond this line, and resting upon both subcarboniferous and Devonian rocks, numerous small outliers of lower coal-measure strata exist. One of considerable extent is found resting upon the Devonian rocks, and reaching from Muscatine nearly to Davenport.

Almost all the coal of Iowa is found in the lower and middle Coal-measures; much the greater part, in the lower. The region occupied by these two divisions on the west and south of the Des Moines river is about equal in area with that occupied by the lower alone upon the east and north side. Thus that river passes through the productive coal field of Iowa as now determined, near its center. In the lower half of this area, particularly along the Des Moines and Skunk rivers and their branches, the valleys are often found to have been eroded through the Coal-measures, exposing the Subcarboniferous limestone, which in this region is invariably the St. Louis division. But that prominent angle of the coal field in Marshall and Hardin counties is found to rest directly upon the equivalent of the Kinderhook beds, the St. Louis limestone and all other members being absent. Leaving the Iowa, and going westward to the Boone and Des Moines rivers along the northern border of the coal field, we find at Webster City in Hamilton county, and at Fort Dodge in Webster county, the Coal-measures resting again immediately upon the St. Louis limestone, while the equivalents of the Kinderhook beds are found coming up to the surface northward of those localities in Pocahontas, Humboldt and Franklin counties. Thus it will be seen that if we except the absence of all the rocks of the Chester limestone epoch, the only real unconformability of the Coal-measures, so far as we now know, consists of the overlapping of the northeastern corner of the coal field from the St. Louis limestone upon the Kinderhook rocks. We also see that there is still greater unconformability among the members of the Subcarboniferous period themselves.

The characters, both paleontological and lithological, of the St. Louis limestone, remain almost unchanged from the northern to the southern limits of its extension in the State, a distance of two hundred miles. The trend of its eastern and northern border evidently does not partake of the angle which the outline of the coal field forms in Hardin and Marshall counties, but conforms more nearly with the older formations in that respect.

The characters of the Kinderhook beds are more changed as they extend to the northward from their typical localities, yet they may be readily identified, both by lithological and paleontological characters. The beds become more calcareous to the northward, and in the counties of Franklin, Humboldt and Pocahontas they consist entirely of limestone ; yet the peculiar fine-grained, yellowish sandstone so characteristic at Burlington is found as far north as Tama county. At this point there is a fifteen foot bed of fine oolitic limestone resting upon it, which is referred almost without hesitation to the oolitic member as seen at Burlington. The limestone of its most northern extension is also principally oolitic.

In view of the foregoing facts the following conclusions are offered.

From the time of the Potsdam period to the close of the Kinderhook epoch of the Subcarboniferous period, there seems to have been a regular and gradual recession of the sea to the southwestward. At the close of that epoch, or in the early part of the Burlington limestone epoch, there was a very marked recedence of the sea, so that the characteristic limestones of that epoch did not reach farther north than the southern part of Johnson county. This recedence then continued gradual until the close of the Keokuk limestone epoch, at which time the St. Louis limestone sea re-occupied nearly the whole area formerly occupied by that in which the Kinderhook beds were deposited. At the close of the St. Louis limestone epoch there was so extensive a recedence of the sea that the Chester limestone did not probably reach within two hundred miles of the southern limit of Iowa. At the close of this last Subcarboniferous epoch there was another remarkable re-occupancy of shallow seas, so that the Coal-measures received their first deposits, not only upon the surface of the St. Louis limestone, but also overlapped upon the Kinderhook rocks, and doubtless others besides; for we have no assurance that the outliers before referred to were not at one time connected parts of the great coal formation.

Iowa State University, March 2d, 1868.

Art. XXXVII.—*Remarks on the Sedimentary Formations of New South Wales, illustrated by references to other Provinces of Australasia;* by the Rev. W. B. Clarke, M.A., F.G.S., F.R.G.S., etc.*

If we inspect the map of Australia, we observe that the coasts of Victoria, New South Wales and Queensland, follow the general directions (with some irregularity) of the Cordillera, or elevated land separating the waters flowing directly to the coast from those which, draining the interior, disembogue to the S.W.

The Murray river receives some part of its tributaries from the highlands of Victoria, and others from New South Wales; whilst the Darling and its tributaries collect the remainder of the supply, from as far north as 25° S.

The Cordillera thus sweeps round in an irregular curve from W. to E. to the head of the Murray—and thence, northerly and northeasterly, to the head of the Condamine; trending northwesterly from that point to 21° S., whence it strikes to the north, terminating its course at Cape Melville, in 14° S., about the meridian of 144° 30′, which is that of Mount Alexander in Victoria.

The more westerly and southerly trend of drainage is represented by the Thomson and Barcoo rivers, which carry off the waters of the Cordillera at the back of the Barrier Ranges to Spencer's Gulf. The meridian of the head of that gulf is, therefore, the western limit of East Australia.

The Cordillera itself, described by Strzelecki in 1845, was traced by him through a considerable part of its diversified course as understood by him), from the southern point of Tasmania o the parallel of 28°, in longitude 152°; but not further westward than 146° on the parallel of Mount Alexander. It is, however, doubtful whether the ranges between this furthest western point and Wilson's Promontory, where he considers the Chain to be cut off by the sea, is anything more than a spur in that direction.

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* From a pamphlet received from the author.

But the extent of the Cordillera westerly, to its termination on the border of South Australia is so well defined, that there can be no question that the S. W. and W. extension has as true a character as any part of the Northern prolongation. This may be geologically deduced from researches of the Geological Survey of Victoria. That province is limited, at its eastern corner, by a line joining Cape Howe and the head of the Murray, so that the boundary crosses very near the highest point of all Australia, which Strzelecki made 6,500 feet above the sea, but which subsequent observations have shown to be 7,175 feet. This correction rests on observations made by myself, in 1852, and a re-discussion of them, in comparison with results obtained by Professor Neumayer in 1862. On 8th May, 1852, I made the highest point of Kosciusco, 4,077 feet above my then base, at 3,098 feet above the sea, which therefore came out 7,175 feet; and in February, 1863, Professor Neumayer wrote me word that he made the highest peak in November, 1862, 7,175 feet. This makes Kosciusco's summit above the crossing place of the Indi or Hume river, at Groggan's, 5,425 feet.

The 144th meridian to the northward limits very nearly all the high land of the East Coast to Cape Melville, whilst the 142nd meridian limits to the westward the basin of the Darling, including part of the drainage along the Thomson and Barcoo from the head of the Flinders, to where it passes into South Australia, on the 141st meridian.

Thus, all this enormous drainage of western New South Wales and southwestern Queensland is, as it were, bounded by ranges of high geological antiquity, the Grey and Barrier groups being of undoubted similar age to the mass of the Eastern Cordillera.

It has long been known that the strike of the older sedimentary rocks all through the Cordillera, in Victoria, as well as in New South Wales, it is generally meridional; so that in the former province the beds strike across the Cordillera, whilst in the latter they form various angles from parallelism with it to a transverse direction, as the Chain doubles and winds irregularly in its course.

This is the experience of the Victoria Survey, and my own traverses across various points of the Cordillera in New South

Wales and Victoria, establish the fact of a normal meridional strike of the older strata. So distinct, indeed, is this characteristic, that the settlers in various parts of the country have been accustomed to trace the direction of north and south by the strike of the slates.

It sometimes happens that, owing to the high angle of dip, and the effect of denudation on the overlying formations, the Cordillera itself becomes in places almost knife-edge, so that in New South Wales it presents occasionally a *divisa aquarum* not more than nine paces in width; whilst in Maneero to the south, and New England to the north, it spreads out in a plateau, on which eastern and western waters rise close together, and sometimes overlap. These different features have a variable geological aspect as well as value; for owing to the strike of the older rocks, the breadth of the Silurian formations, which, as in other countries, are repeated by recurring folds, may be more exposed in Victoria than they are in New South Wales; and owing to the curve of the Cordillera, probably the same beds are traceable to the north which occur in the south; as, for example, the auriferous rocks of Omeo and Peak Downs, which are on the same meridian; and thus the meridional strike is exhibited along the northeast coast, where there are alternations of old rocks forming precipitous cliffs, with low valleys and beaches separating those alternations.

Independently of this arrangement, the whole of the Central area inside the Eastern Cordillera has a trend to the south and west, so that the waters collected between 22° and 37° S., on the east of South Australia, find their way to the sea at the eastern corner of that province.

We might naturally assume that the same order of deposits is to be expected throughout the Cordillera; but there is a singular exception. Whilst marine deposits of Tertiary age are found along the coast of Western Australia, and along the southern coast from Cape Leuwin to Cape Howe, there are no known *marine* Tertiaries in any part of the coast of New South Wales and Queensland up to the Cape York Peninsula; and the reason of this may be, that, as indicated by phenomena before pointed out by me, but which on this occasion cannot be further dwelt upon, the eastern extension of Australia has been cut off perhaps by a general sinking (which is in accordance with the Barrier Reef theory of Mr. Darwin), and which has some support from the fact that there is repetition of Australian formations in the Louisiade Archipelago, New Caledonia, and New Zealand, in the latter of which occur abundant tertiary deposits, in which case the intervening ocean may be supposed to cover either a great synclinal depression or a denuded series of folds.

Relatively speaking, therefore, the Cordillera of the Eastern Coast has not been subject to the changes which introduced the relics of a Tertiary ocean. At any rate, no evidence is known to me of *marine* Tertiaries on the lands north of Cape Howe.

Another fact worthy of notice, as showing the probable ancient geological vicissitudes of Australia is, that the great Carboniferous series which is so prominent in New South Wales and in parts of Queensland, but which is less distributed in Victoria, and there only partiallv and irregularly as to the portions still remaining, has been broken up and carried away, so as to have left the various members dislocated, ruined, and separated in such a way as to allow no clear view to be taken of the whole till all the separate portions have been separately examined; and to the want of this personal examination on the part of certain Paleontologists and others, who have never yet seen the Carboniferous formation of New South Wales, is to be attributed the perseverance with which they so long disputed facts as attested by geologists in New South Wales, who are familiar with the latter and with Victoria also.

In consequence of the absence of marine tertiary deposits in New South Wales, and the occurrence of a more complete series of the strata in the sections of the Carboniferous formation, there has arisen a difficulty in collating the gold deposits with those of Victoria; and, in this respect, at present the upper deposits in the former province cannot be assigned with any precision to the epochs adapted by Mr. Selwyn for the latter. And it also follows, that his view of the distinct ages of Pliocene auriferous and Miocene non-auriferous gravels cannot be tested in New South Wales; if, indeed, it has not already been tested by the actual discovery of gold in the so-called Miocene deposits themselves as they occur in Victoria.

So far as is at present known, the gold is derived chiefly from the Lower Silurian formation; but researches conducted for me at H. M. Mint in Sydney, prove that it exists in almost every distinctive rock in New South Wales. In this province the alluvial deposits are not so extensive as in Victoria; but this probably arises from the fact previously mentioned of the strike being in Victoria transverse to the direction of the Cordillera; by which means the currents which distributed the drift had a wider area of gold-bearing materials to denude than in New South Wales, where, I conclude from numerous examples, the principal currents were to northward, so that in that province they would coincide with the direction of the Cordillera, and not accumulate the deposits in such low-lying extensive regions as those of the Murray Districts. The same objection would obtain, on the supposition of gradual waste and accumulation from less powerful agency than that of a general rush of water. It is not, however, to be doubted, that there is an enormous amount of gold yet untouched in numerous places in New South Wales, not only in the quartz lodes (or reefs), but in gullies and plains where alluvial gold diggings will yet be discovered.

The distinctive differences in material mineral wealth between Victoria and New South Wales are not altogether confined to gold, or tin, which latter metal is well represented in the New South Wales Court; but coal, iron and copper, and perhaps lead, also exhibited, prove more than an equivalent of the great amount of gold at present in Victoria.

At the Universal Exhibition of 1854 the present writer exhibited a collection of rocks and fossils, illustrating the whole of the geological formations of Australia, and these were enumerated in their stratigraphical order in the published catalogue. On this occasion, it has not been possible to complete a similar and more extended collection, owing to the effects of protracted illness; but it may be useful to introduce a few remarks on the various geological epochs as they represent themselves in New South Wales, with a brief statement as to their connection with other portions of Australasia.

AZOIC AND "METAMORPHIC" ROCKS.

There has not been sufficient evidence yet collected to show that these rocks have been ascertained to exist in Eastern Australia, although in Tasmania rocks of a doubtful class (and which may, perhaps, be only highly altered Lower Silurian) have been referred to them by Mr. Gould. The existence of gneissoid strata and of slates of very ancient aspect, has also been well known in New South Wales, with occasional unfossiliferous limestones; but it would be premature to place them, without doubt, under the present head. Some of those mentioned under the First Epoch of Strzelecki have, on close inspection, appeared to the writer to be merely the products of transmutation, nor is such an improbable result, seeing that in Australia some slates have apparently been changed into granitic rocks. It is, at least, certain that such rocks, except in Tasmania, generally occur in the immediate vicinity of granites, though the latter frequently occupy large areas both in Maneero and in New England, as well as along the Cordillera, and in independent masses along the coast. In Western Australia, where an enormous region is occupied by granites, and the older formations are represented only by small patches of slates, whilst the granites themselves remain bare, these patches are found on the flanks of the granitic bosses, and at extremely wide intervals;

nor have I been able to detect, among the numerous collections which have passed through my hands, distinct evidence of any but doubtful examples of those foliated rocks which belong to the so-called Primary epoch. In Southern Australia, also, there does not appear to be any considerable amount of strata which could be referred to this epoch.

LOWER PALEOZOIC ROCKS.

Of these there are undoubted evidences in some limited districts of Tasmania, whilst in New South Wales and Queensland considerable areas are occupied by them.

The greater mass of them, in the two latter provinces, appears to belong to Upper and Middle Silurian; the mudstones of Yarralumla, with Encrinurus and Calymene; the Coralline and Pentamerus beds of Deleget and Colalamine; the Tentaculite and Halysites beds of Wellington and Cavan; and the beds with Calymene, Encrinurus, Beyrichia, and others with Illœnus, Harpes, Bronteus; Brachiopoda, including Strophodonta and Radiata embracing Star-fishes, point to the existence of at least the Upper Silurian formation on both flanks of the southern part of the Cordillera. There are also numerous corals included in the list given by me in the Southern Gold Fields (p. 285), which also confirm the same determination; and it may be added that the above, and other fossils of this age mentioned by me elsewhere, have been examined by Paleontologists of eminence in Europe. Such are the genera Favosites, Cœnites, Ptychophyllum, Calamapora, Syringopora, Emmonsia, Alveolites and Cystophyllum, &c. These, perhaps, might not alone satisfy a doubt, but with them occurs Receptaculites; since 1858, when these were determined, I have detected Halysites, which may settle the question as to Upper Silurian. Wenlock beds seem to be well developed on the Deleget.

In Victoria, numerous species of Grapolites have been found, but during my explorations of New South Wales I discovered none. It is only recently that they have been found in the most southern part of the province on the M'Loughlan river and also in other spots in the basin of the Snowy river, near the boundary of Victoria.

In Tasmania I saw fossils similar to those of New South Wales, from beds on the Gordon and Franklin rivers; but Mr. Gould has since placed them partly as Lower Silurian. Lower Silurian beds also occur on the Deleget river, where both the upper and lower have a generally meridional strike, but varying dips.

In Queensland, Mr. Daintree has confirmed the fact of the existence there of Silurian rocks identical with those of Victoria; and my own examination of the Brisbane Slates led me to compare them with the auriferous slates of the Anderson's Creek Gold Field. The quartz veins of that neighborhood were found by me in 1851 to hold gold, and some very recent researches have increased the expectation of valuable deposits there, in addition to those which have already been opened on the Burnet, Crocodile Creek, Mount Wyatt, the Burdekin, Talgai, and Star Creek; about Peak Downs, and in other places.

The Gold Field of Fingal in Tasmania is also partly occupied by rocks of Silurian age, the lithological structure of which is identical with rocks in New South Wales and Victoria.

Copper is abundant in strata which may be referred to the same epoch; but a peculiarity which I have observed in most of the copper localities is, that the ores do not occur in lodes of the usual character, but sometimes, as on Peak Downs in Queensland, they follow the planes of the strata, and generally in New South Wales assume a dome-like form, rising in bosses at intervals without continuous surface connection. The Burra Burra Copper Mine of South Australia has also something of the same character. I have in my possession Pentamerus from Bombala, in which the shells are embedded in copper ore.

Specimens are exhibited from Bombala and Cavan, not only of Fossils, but of Copper, Lead, and Iron. (No. 475 & 474.)

MIDDLE PALEOZOIC ROCKS.

Mr. Jukes has shown cause why the term Devonian should be eliminated, referring the so-called beds to the bottom of the Carboniferous formation.

It is probable that such will have to be the fate of certain strata in Australia, the fossils of which have at once a Silurian and a Carboniferous aspect; being connected with the former by certain corals, and with the latter by the occurrence of Lepidodendron, Sigillaria, and other Lower Carboniferous plants.

There is undoubtedly a regular passage downward from the marine fossils of the acknowledged Lower Carboniferous beds of New South Wales, to others which very much resemble the so-called Devonian beds of England; and a series of shells, corals, &c., from the Murrumbidgee, which I submitted some years ago to Messrs. Salter & Lonsdale, through Sir R. I. Murchison, Bart.,* excited doubts as to their belonging to any but Silurian and Carboniferous deposits. Among these were Phanerotinus, Loxonema, Atrypa *reticularis*, Orthis *resupinata*,

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* See Murchison's "Siluria," 3d ed. p. 296.

Murchisonia, Strophomena, and Spirifera of various species, some like Devonian. Loxonema is known to me as occurring in the lower marine beds of the Hunter river basin—certainly below the upper coal beds.

There appears to be an intermixture, and such is the case with certain strata to the westward of Wellington, in which some of the fossils have the Carboniferous type and others the Silurian. In the list before mentioned these are included in Passage beds.

In Victoria, near Mount Tambo, in Gipps Land, and again near the head of the Murray, there are some limestone beds with fossils, which I visited in 1851, and then believed to be of the same age as the lowest Carboniferous rocks of New South Wales. The Victorian geologists consider them Devonian.

In Queensland, the Burnet Range and tracts about the Bowen Gold Feld and Burdekin (in which river limestones with fossils occur), are strewn with spoils of a formation which Mr. Daintree calls Devonian. From the former locality I have had many collections, and among them all I find Productus in alliance with Trilobites which appear to be older than Carboniferous. But, if Mr. Jukes's arrangement holds good these will probably be placed in the latter formation. On the western flanks of the Cordillera, near Yass, and on the eastern, along the Shoalhaven river, and again near the Hanging Rock, New South Wales presents numerous bands of limestone full of such fossils; and it may be doubtful at present whether these lie on the horizon of the Devonian, or whether they belong to some portion of the Upper Silurian. As these beds appear to range all through the country on a nearly meridional strike, on both sides of the Cordillera, they are traceable in widely different places; and it may eventually be determined that, though in close contact, there is really a distinction of formations, only to be detected by accurate survey. So far as Lepidodendron is concerned, that plant occurs in some places in association with beds that are decidedly younger than any called Devonian, near Pallal on the Horton river, and on the Manilla river in Liverpool Plains, and in the gold drift of the Turon river, which has been derived from beds of transmuted sandstone belonging to the coal beds at the head of the river. Near Wellington, also, Lepidodendron has been found in hardened rock of similar origin. At Canoona Gold Field, in Queensland, Lepidodendron occurs in hardened shales; and at Goonoo Goonoo, on the Peel river, in New South Wales, it occurs in fine grey sandstone, with Ferns and Sigillaria in close proximity to beds of marine fossils which are certainly Lower Carboniferous.

Besides these *fossiliferous* evidences of supposed Devonian age, there are beds of grit, sandstone, and conglomerate, occupying positions of extreme doubtfulness as to age, not only in Victoria, but also all along the coast ranges of New South Wales, which, as described by me, and confirmed by Mr. Daintree, are certainly older than some parts of the Carboniferous formation. They make a near approach to the "Old Red" of Europe. In my Report to the Government of New South Wales (6th March, 1852), I have mentioned that I had traced these beds "from the head of the Shoalhaven to the head of the Genoa;" and Mr. Daintree, in his Report to Mr. Selwyn, Director of the Victorian Survey (26th May, 1863), adopts my description, word for word, as applicable to "the Grampian sandstones, the conglomerates south of Mount Macedon, of the Avon river and Tambo, Gipps's Land;" and he adds, "there can be little doubt they are all members of one great formation."

At Mount Tambo, according to Mr. Selwyn (1866), they underlie the limestone of that locality, which he therefore considers as probably Carboniferous; and this, as stated above, was my view in 1851.

About Eden (Twofold Bay), and Panbula and Merrimbula, to the north, there occur a series of beds which, in 1851, I also ranked as Devonian; but, on visiting the district in 1865, I was inclined to think they might be much older. Nevertheless, they are connected with Porphyries, with double-headed hexahedral crystals of quartz, which are common in countries assumed to be of the age of "Old Red." After all, there will have to be an adjustment of this and other questions, which may hereafter distribute very differently parts of formations which at present are considered fixed.

In Western Australia, Mr. H. Gregory indicated on his map, and in his Report, the existence of Devonian rocks near York, and in other parts of that colony. Having examined the rocks so indicated, I can only state my belief that they have no pretension to any such antiquity, and are probably mere collections of loose granitic matter and other drift cemented by ferruginous paste, which has since become transmuted into concretionary nodules and hæmatite. There are also pebbles of trap, much decomposed, in the so-called Devonian.

UPPER PALEOZOIC.

That this division of rocks is fairly represented in New South Wales there can be no dispute. It has been long determined by all Paleontologists, that the lower Carboniferous marine beds of Europe are represented by the beds immediately below the Upper coal measures of the Hunter river, of the Illawarra, Talbragar, &c.; and we know also, that fossils of the same age occur in a part of Western Australia, near the Irwin river in Queensland; in Tasmania, and in Victoria.

Associated with them, both above and below, in New South Wales, Coal beds of various thickness (from 3 to 30 feet) occur. In the Newcastle basin alone there are at least 16 seams more than 3 feet thick, sections of which have been published by John Mackenzie and W. B. Clarke, and are exhibited. (See No. 477.) Up to a comparatively recent period, it was not known that under the marine beds below these coal seams, other seams occur bearing the same genera of plants as in the upper beds, of which Glossopteris and Phyllotheca are very abundant. When this fact was first published by me, it gave rise to controversy; but the truth of my conclusions has been confirmed since by Mr. Daintree, who, visiting and examining the spot in dispute, found four or five seams in the position to which they had been assigned. Now, below these lower coal measures there is an enormous thickness of fossiliferous strata, in which the fossils (as before stated) gradually assume what has been called a Devonian aspect. The opposition to this determination has arisen from a preconceived idea that strata bearing Glossopteris could not be Paleozoic, and therefore, that the upper coal measures of Newcastle had no right to be considered older than *Oolitic.* But whilst these upper measures produced a fish of undoubted Paleozoic character (Urosthenes *australis*), Cleithrolepis *granulatus*, Myriolepis *Clarkei*, and other Ichthyolites, examined and determined by Sir P. de M. G. Egerton, Bart., to be Paleozoic, have been found by me at least 1,000 feet higher, and of which photographs are exhibited on this occasion. (See No. 351.)

This dispute, therefore, ought long ago to have been settled; but unfortunately it was taken up out of the Colony, and found some support in the writings of DeZigno, author of "*Le Piante Fossili dell' Oolite.*" Since then he has modified his views, and, in a subsequent publication, in the "*Rivista periodica,*" Padova, vol. xiii, 1863, admits that the Australian coal beds are rather *Triassic* than *Oolitic.* He still, however, does not quite comprehend the whole question.

Above the coal measures, including Urosthenes and Glossopteris, *i. e.*, in the Hawkesbury and Wianamatta beds, in which Cleithrolepis, Myriolepis and Palæoniscus occur without Glossopteris, Baron De Zigno imagines, from the way in which the evidence has been put before him, that beds with Pentacrinites, Ammonites, and Belemnites, which will be mentioned hereafter, interpolate the beds with Palæoniscus, &c. Nothing, however, of the kind has ever been found in Hawkesbury or Wianamatta beds; and the only fossils of the genera named occur in

Queensland, full 600 miles distant. Professor M'Coy having believed the coal of New South Wales to be Oolitic, and believing the Pentacrinites, &c., to be Oolitic also, and Lepidodendron having been stated to be found in beds below the coal in marine beds of assumed Devonian age, it was too hastily inferred that Professor M'Coy and myself were writing of two distinct *coal* epochs.

That the coal measures of New South Wales are, however, truly Carboniferous, has been since determined by plant evidence; for in Queensland, where the Newcastle coal measures can be identified, a plant very near to, if not the same as, Alethopteris *lonchitica*, has been found, and there are in the present Exhibition several examples of it. (See No. 470.) Moreover, near Stroud I long ago detected a magnificent fern, in beds which belong to the Hunter river coal measures, which Sir C. Bunbury has named *Adiantites eximius*.

Whether the masses of coal exhibited look more like a Secondary than a Paleozoic coal, may be fairly left to the decision of competent judges. (See Nos. 214—233.)

Another ground on which the age of the New South Wales coal beds was disputed is, that in Victoria there are certain beds which (*me teste*) resemble some of my Wianamatta beds, and therefore, assuming them to be *Oolitic*, New South Wales was involved in that dictum also. Now, the true European coal measures (according to Mr. Selwyn), "so far as is known at present, do not exist in Victoria;" nor has Glossopteris been found there at all. Moreover, the Survey has sunk through 4,000 feet of consecutive beds, without finding a profitable seam anywhere; and, though the limestones of Gipps's Land are acknowledged as Lower Carboniferous or Devonian, there is not an atom of evidence to be obtained in Victoria as to the Secondary age of the New South Wales coal. Thus stands the question at this moment. If now we turn to Tasmania, we have clear evidence as to the occurrence there of true Paleozoic coal, and if we pass on to Queensland we have equally clear evidence; and, what is more, there are sections on the Bowen river (full 1,000 miles from Sydney), in which the whole history of the coal beds may be read off without error.

Mr. Daintree writes thus :—"The Bowen river Coal series would afford more conclusive sections in the upper portion than your own; since, besides the seams of coal lying at the base of the Bowen river series, *interstratified with beds containing a marine fauna*, which Professor M'Coy acknowledges to be *Carboniferous*, there are likewise beds *containing a nearly similar fauna, resting on beds with abundance of imbedded Glossopteris.*"

I learn also, from the examination of both Fauna and Flora, specimens of which were in my possession before Mr. Daintree had visited Queensland, that the former contains the identical species described by M'Coy (*Annals Nat. Hist.*, vol. xx), such as Productus *brachythœrus*, Pachydomus *globosus*, Allorisma *curvatum*, whilst the latter contains Phyllotheca *australis* and Glossopteris *Browniana*, and others, which were assumed to be Oolitic at Newcastle, but must be admitted to be Paleozoic on the Bowen river.

The coal seams on the Bowen river are of variable thickness, but a ten-foot seam has been noticed.

Mr. Gould, in his Report to the Government of Tasmania, October, 1861, also states that the Mersey river worked coal seam belongs to the formation with the same marine fossils as in Queensland, and on the Hunter in New South Wales.

Having visited the Tasmanian locality for the purpose of inspection, I can confirm all that has been stated respecting the occurrence of the marine Paleozoic fossils, *Orthonota*, *Spirifera*, *Fenestella*, *Pachydomus*, *Theca*, &c., in association with and immediately above the coal.

So far, then, the question about the age of some of the Australian coal must be considered as settled ; and if, as in Illawarra, the coal beds overlie the marine beds, as they do also in the Fingal district of Tasmania, it would appear that all these separate occurrences belong to one thick series, in which marine beds and fresh-water beds interpolate each other. But, assuredly, in that case, the arrangement adopted must express the order as follows :—

4. Upper coal measures.
3. Upper marine beds.
2. Lower coal measures.
1. Lower marine beds.

So far as I know, the latter rest frequently on a conglomerate, which in Tasmania I found to contain undoubted Carboniferous fossils.

Since the Exhibition of 1862, on which occasion, in a paper on the Coal Fields, I noticed the occurrence of Oil-bearing Cannel Coal at the foot of Mount York, and at Colley Creek in the Liverpool Ranges (not on eastern waters), the former has been in great request for the purpose of producing illuminating oils ; and the produce has been brought into the market. In the former locality, and in Burragorang, I have made some recent researches, which have satisfied me that these can only belong to the Upper coal measures, for they bear distinct evidence in the fronds of Glossopteris, which are very clearly impressed upon the beds at Mount York ; whilst at Burragorang the blocks of Cannel are found in an intermediate position, between the top of the coal measures and the upper marine beds, which, if not the overlying measures, bear the very strongest resemblance to the Hunter river series.

In Illawarra, also, there are shales which are above that geological position, and which produce oil for illumination, but are not of the peculiar character of the Cannel at Mount York, which, in a great degree, resembles the Bog Head mineral of Scotland, only it is more valuable. Specimens of all the products under the present heading will be found in the Exhibition. It has been an object of inquiry whether Petroleum springs exist in New South Wales. Such have been reported from the Corong in South Australia, and from Taranaki in New Zealand, and from Victoria. The former is, we learn, a mistake; being probably at a point where certain animal substances have decomposed. In New South Wales there are also two localities, known to me for many years, in which Petroleum exudes; and there are two or three in Western Australia, the products from which I have examined. Nothing of value has as yet been found. (See Mr. Keene's collection exhibited in London, 1862, and again exhibited, pp. 81–89.)

SECONDARY ROCKS.

I have previously made mention of the Hawkesbury and Wianamatta beds; and a collection of them, illustrated by a catalogue, was exhibited at Melbourne. Some of these were also shown in the Universal Exhibition of 1854, and therefore have not now been repeated.

Whether they be acknowledged hereafter as Paleozoic (which the fishes determined by Sir P. M. de G. Egerton, Bart., would justify), or whether, with Mr. Selwyn, we consider them (against that evidence) to be Secondary—or whether we suppose, with him, that the beds in Victoria called by him Secondary are a portion of my Wianamatta beds—there is nothing to explain the statement made by de Zigno, in his valuable paper before the Academy of Science, in Padua, on 23rd April, 1863, in which he says:

> Altri depositi pure d'incerta classificazione ci si schierano innanzi prendendo ad esaminare i terreni a combustibile fossile della Nuova Galles meridionale e della Tasmania, che il M'Coy aveva fino dal 1847, collocati nel piano dell' Oolite, mentre Clarke annunciava di avervi rinvenuto i Lepidodendri dell' epoca carbonifera.
>
> Successivamente le nuove indagini instituite dal M'Coy lo ponevano in grado di chiarire come i resti trovati dal Clarke appartenessero a depositi collocati ad una grande distanza di quelli le cui piante accenavano ad un' epoca più recente.

* * * * *

Egli cita in questi ultimi depositi la presenza di quattro Cicadee e di una *Tæniopteris* multo affine alla *Tæniopteris vittata* dell' Oolite di Scarborough, e nota come presso Volumbilla abbia trovato Belenniti, Pentacriniti e varie conchiglie che s' approssiomano alle specie proprie dell' Oolite inferiore, del Lias e del Trias. (p. 148–9).

Now in this statement are three things to be reconsidered:—

1. It has not been said by me that the Lepidodendron, &c., were in the same beds with Glossopteris (though evidence has come out recently to the effect that these plants have been found together at Newcastle), but it has been held that the Glossopteris Coal beds and the Lepidodendron beds are part and parcel of one great formation.
2. In New South Wales no Cycadites and no Tæniopteris have been ever found, though they occur in Victoria in the beds considered by the geologists there to belong to the Wianamatta beds.
3. Neither in the Victoria beds, nor in the Wianamatta beds, has ever been found a Belemnite, a Pentacrinite, or any shell, save a fresh-water Unio in Victoria, and one shell in New South Wales from the fish-bearing shales.

There is, however, a far more important matter to be rectified.

When I first reported the discovery of Secondary fossils from Wollumbilla in Queensland, it was as *Cretaceous or Jurassic;* but Professor M'Coy described them, in September, 1861, as *Lower Secondary*, and as the marine representatives of the formation, to which belonged, in his opinion, the Victoria "carbonaceous" beds, and the coal measures of New South Wales, *i.e.*, of the age of the Scarborough Oolite. Among the Wollumbilla fossils were some which looked older than Cretaceous ; and therefore, certainly guided by Prof. M'Coy's determination, I adopted his view of an older period, and even considered that some of the fossils indicated a Triassic age ; (there was certainly a brachiopod which looked older than Triassic;) consenting to the possibility that the Wollumbilla beds might prove really to be of the same age as the Wianamatta beds. But I have learned two things since, first, that the fishes of the latter are Paleozoic, and secondly, that the Wollumbilla fossils on comparison and examination in Europe, whither I sent them, are by geologists there considered to be really *Cretaceous;* and as Professor M'Coy has himself published two Cretaceous species from Queensland, in 1865, and as I have collected evidence to geologically connect their localities (Flinder's River) with that of Wollumbilla (though otherwise so widely separate), there will be the less difficulty in allowing the Cretaceous *epoch,* first suggested by myself as applicable to fossils in *situ*, to be acknowledged as well developed in Queensland. But we shall then see how little is its relationship with the Wianamatta, and how still less with the Victorian beds.

This reference to a very important circumstance leads me to suggest, that whether the Wianamatta series is to maintain a Paleozoic pretension or whether it is to ascend to the Trias, the arrangement which will be found most correct will probably be represented somewhat in this wise :—

4. Cretaceous. Wollumbilla, Flinders, &c., (Queensland) and Western Australia.
3. Inferior, or Great Oolite. Deposits at Wizard Peak, &c., Western Australia.
2. Trias, Victoria.
1. Paleozoic. Wianamatta, Hawkesbury, and Coal beds of New South Wales.

In which arrangement, I would place the Victorian "carbonaceous" above my Wïanamatta beds. Of course, subsequent discoveries may modify such a view, and lead to a final settlement of opinion, by enabling geologists to fill up the *gaps* which undoubtedly exist; proving, perhaps, that the Cretaceus fossils picked up in drift by Mr. Selwyn indicate the former existence of Upper Secondary rocks in that province, as the Ammonite brought to me on the Clarence River Coal Fields in 1853, may indicate the former presence there of an Oolitic formation.

That Cretaceous or Jurassic rocks formerly occupied and still occupy an enormous range in Queensland, I can now assert, having obtained some of the additional information which I proposed to collect in 1861. I have now been able to discover that rocks of the above epochs range from the east of Wollumbilla across the Maranoa and Warrego to the Nive and Barcoo; thence along the head of the Thomson to the Flinders, and so round by Tower Hill and the Belyando back to the Amby and Maranoa Rivers; not, of course, in one uninterrupted area, but resting on the Carboniferous and other Paleozoic formations, thus exhibiting a very extensive distribution of Secondary rocks; and it will probably be found that various groups of the Jurassic epoch are represented there.

It is certainly singular that some well-known species of European reputation, or their representatives, are found in the Western Australia Oolite, such as the following of the Great Oolite :—Trigonia *costata;* Ostrea *Marshii;* Ammonites *Moorei;* Lima *pectiniformis;* Avicula *Munsteri*, &c.

None of these have, however, been found in Queensland, New South Wales, in Victoria, or Tasmania; but in the latter island, there are undoubted equivalents of some part of the Wianamatta series, as well as of the Coal measures and lower Carboniferous beds of New South Wales.

In New Zealand the greater part of the Coal measures is not Paleozoic, but some of it is said to be Secondary, to which epoch also belong the Jurassic Plesiosaurus and Ammonites; and Triassic Aviculæ and Monotis.

In New Caledonia, there is also a distinct Triassic series, of which some of the fossils are akin to those of New Zealand. But, at present, neither has this nor the Belemnites of Queensland been found in New South Wales.

So far as the question of Coal is concerned, no Coal seams (but only thin patches or very limited layers) have been found in the Wianamatta or the Hawkesbury rocks, that can be compared even with the alleged Secondary deposits of Victoria; and in Queensland, where workable seams do exist, the fossils of New South Wales are also found. In the Secondary marine beds of Wollumbilla and the Amby, gold in minute visible particles was found by me in some of the quartz pebbles cemented with the shells, and a small quantity was detected by crushing the whole, shells, pebbles, and the calcareous cement together.

TERTIARY ROCKS.

Throughout the whole of Eastern Australia, including New South Wales and Queensland, no Tertiary *marine* deposits have been discovered. There are, however, in various places of New South Wales, patches of *plant deposits* which, according to the frequent notices of geologists, may be referred to some period of the Tertiary epoch. A silicified sandstone, or quartzite, of this kind, full of impressions of ferns and leaves of trees, but not known to be now living, occurs at Jerara Creek, not far from Yass. (See No. 475.) It is probably Miocene. On the summit of the Cordillera, near Nundle, above the Peel River Diggings, occurs a ferruginous bed full of leaves. Both these localities are represented by specimens in the Exhibition. On the Richmond River occurs a white magnesite, full of yellowish impressions of leaves. At Keewong, in the county of Gowen, there is a bluish deposit of fine aluminous matter with black impressions. From a depth of 60 feet in a shaft near Bungonia, a pale yellowish white deposit with similar impressions was brought up; and on the summit of "a made" hill, above Kiandra Gold Field, at a height of 4,000 feet above the sea, and in a region now partly covered with snow many months in the year, there is a deposit of black clay with such casts of leaves as occur in similar clay near Hyde in New Zealand.

No botanist is prepared to declare what is the exact age of such deposits. But some of the leaves are supposed to represent among others the foliage of *Fagus*; yet, it was only in 1866 *that a beech forest* was discovered, by the Director of the

Botanical Gardens, growing on the Clarence River. On comparing the living leaves with the impressions in the various deposits mentioned, I can see no identity. This is a point in Geology not yet fully dealt with.

The most remarkable instance I have met with is on the coast, about forty-two miles north of Cape Howe, where, at a place called Chouta (between Tura and Boonda) a cliff about 100 feet high, formed of sand and white silicate of alumina, contains beds of lignite charged with sulphid of iron, and which are full of phytolites much allied to the living vegetation. From the clays, some of which are nearly kaolin, articles of pottery have been formed, which, with the clays and sands, are exhibited. (See Nos. 269 & 371.) It has been proved that, by distillation, a fair proportion of lubricating oil may be produced from the ligniitiferous clay, and other products are expected to result from these deposits. The cliff is about 60 feet thick from the sea to the top of the clays, and borings below the sea level have shown a still greater thickness.

These deposits lie between the horns of the little bay at Tura and Boonda, resting at one end on the highly undulating Paleozoic rocks, and at the other on a mass of Porphyry. They were, formerly, no doubt, deposited in a depression among the slopes of the hills, but the wearing away of the coast has left a cliff of clay and sand instead of the original cliff of hard rocks. It is remarkable that, at the south end the rocks assume the character of a breccia of quartz, cemented by siliceous matter (probably like a deposit mentioned by Mr. Gould as occurring in Tasmania) and in it analysis has detected the presence of gold, though some quartz veins at the north end contained none.

My impression at first was that the lignite was recent, but I place the deposits under the present head because it may be possible the plants are not recent ; and some of the hardened clinker-like sands covering the clays remind me of the sands on the coast of Dorset, at Studland, and Bourne Mouth. If this be really a Tertiary locality, it does not contradict the general assertion at the commencement of this section, for no shells of any kind have been detected in any part of these beds. Swampy and stunted plants still grow on the sands which are very wet, and probably reproducing the phenomena beneath them, with the exception of the white clays which were in part derived from the decomposed felspathic matter of the Porphyry. In various parts of Maneero there are lignite-like local thin deposits, but on analysis they have proved valueless.

It may be well to mention, that although there are no such positive indications as exist in Victoria, as to the age of the

Gold drifts which are by Mr. Selwyn referred to Upper and Middle Tertiary, yet there are parallels in New South Wales to certain phenomena that have been observed in that province. Thus, the gold alluvia of the Uralla resting chiefly on granite are covered by a great thickness of basalt, as in various Victorian fields, and at Lucknow, near Orange, as well as at Uralla, under the basalt and with the gold alluvia are found stems and branches of trees, as is the case at Daylesford, in Victoria.

These may be Miocene, or perhaps Pliocene, but the proof must rest on evidence not yet attainable.

PLEISTOCENE AND RECENT ACCUMULATIONS.

In many parts of the existing region, all over the surface, wherever the basal rock is not denuded, as near Sydney, there are local deposits which might be called "till," were any Testacea found in them; and in the interior there are widely-spread accumulations of drift pebbles, which, as on the Hunter and Wollondilly, are rounded by attrition in their long journey from the mountains whence they have been derived. Sometimes, also, the breaking up of conglomerates has contributed to this drift.

In more than one instance, it is clear that the present river channels have deepened since the drift first began to crowd their banks. I have traced one of these drift streams, sometimes at great heights above the valleys, for more than 80 miles. In other places I have found upon the surface, as Strzelecki did in other parts, minerals (especially ores of copper, tin, and lead) which were at a great distance from their sources; and in two instances, that rare mineral, Molybdate of lead, of which no habitat has ever been yet found.

In the great plains of the interior, bones of various gigantic marsupials, fishes and reptiles, are found bedded in black muddy trappean soil; and on Darling Downs in Queensland, univalve and bivalve shells are found in some cases attached to the bones, or deposited over them in a regular series of layers, at intervals of several feet; and of these shells some are yet living in the water-holes of the creeks. These facts are generally known, but it was not till recently that the osseous relics have been found in different creeks throughout the whole of the slopes and plains at the base of the Cordillera in Eastern Australia.

Similar to this are the accumulations of bones in caverns, as at Wellington—at Boree, near the head of the Colo river—at Yesseba on the Macleay river, and other places.

In the Exhibition is a magnificent collection made by Mr. Krefft, from the former locality, and several specimens of bone breccia from the latter place, discovered by Mr. Rudder. (See *Nos. 483e & 469.)*

Along the coast are found ranges of Dunes, with a variety of shells, some of them rare, others recent, as on Port Hacking and Cronulla beach; along the shores of Botany Bay; on the great flat between the Hunter and Port Stephens, and along the Macleay river which now passes for many miles through the shelly accumulations; and about Moreton Bay and in more northern coast openings, shells and marine refuse form deep deposits, from which, as in Illawarra and Broken Bay, a considerable profit is obtained by dredgers and shell-collectors, for the production of lime.

Mr. Rudder illustrates the case of the Macleay by collections of the shells, and by a carefully-drawn map defining the limits of the Pleistocene deposits. (See No. 469.)

All along the coast, from Torres' Straits to Bass's Strait, drift pumice may be found wherever there is a lodgment, generally in the north corner of the little shore bays. That this has gone on for ages is apparent, as in one part of the coast south of Sydney there is an accumulation of water-worn pumice, some distance from the shore, and beyond the reach of the present waves. It is supposed to come in during easterly gales, from the volcanic islands to the northeast.

Raised beaches occur also at various heights on rocky projections of the coast, indicating elevation of the land, of which there is distinct evidence in the recent period, not only in Moreton Bay, near Sydney, and thence to Bass's Strait; but on both sides of that Strait, and as far as Adelaide and King George's Sound. Mr. Selwyn gives data for assuming the elevation of the land to have reached occasionally 4,000 feet in Victoria, but he has no evidence of Tertiary marine fossils above 600 feet. Unfortunately, on the eastern coast, having no marine Tertiaries, we have to found our deductions, as respects New South Wales, on less secure data. Yet we have here evidence of another kind, and pot-holed surfaces of considerable extent have been found by me at various heights from 300 to nearly 3,000 feet.

In a brief abstract like the present, it is impossible to quote authorities, nor has time allowed a more satisfactory digest or a wider range of statements. Nor has opportunity permitted the preparation of sections (save of the Newcastle Coal Field, No. 477) or map to point out relative positions of the formations mentioned by me in this paper. The places named can, however, be seen on such maps as are probably exhibited by English publishers; if not, reference can be made to Petermann's map of Southeast Australia, in Stieler's Hand Atlas, No. 50c.

I have not named the occurrence of the ferruginous deposits *of the* Cape York Peninsula, (though I possess a map, and collections made from about the new settlement and along the coast), because I am not at present aware whether they are Pleistocene or Tertiary. They are very extensive, and cover the bases of Porphyry hills. On analysis of the ironstone, no gold was detected. W. B. C.

St. Leonards, near Sydney, 17 January, 1867.

ART. XXXVIII.—*The Ainos, or Hairy men of Yesso;* by ALBERT S. BICKMORE, A.M.

(From the Proceedings of the Boston Soc. of Nat. Hist., Dec. 4th, 1867.)

THE islands that now form the empire of Japan are four in number: Kiusiu, on the south, opposite Corea; Sikok, a little to the northeast; Niphon, the great island of Japan, to the north; and Yesso, another large island to the north of the latter. In the most southern part of Yesso, on the wide strait, which separates that island from Niphon, is situated Hakodadi, its chief city, and its only port open to foreign trade.

Arriving at this place on my way northward from Yedo to Siberia, at the solicitation of our Consul, Col. E. E. Rice, the Japanese Governor gave me the privilege of going some miles beyond the places usually visited by foreigners and seeing a real village of the Ainos— the aborigines of these islands and the least known of all the people of the east.

From Hakodadi I travelled northward over a mountain range to the active volcano Ko-man-ga-ta-ki, and descending its northern flanks came to the village of Mori on Volcano Bay. Here for the first time I had the privilege of seeing a man and woman of that strange people.

From Mori we followed the shore for fifteen miles to Ya-ma Koosh-nai, sometimes over loose sand, shingle, or boulders, and sometimes along the little paths that lead from one fishing village to another, in a neighboring bay. Terraces extend the whole way, occasionally coming down to the shore and forming bluffs one hundred or one hundred and fifty feet in height, but back of these was another series as much higher. The fishermen near the head of the bay were taking fishes much like our herring, in great quantities, for their oil. The residue in the boiling pots is pressed into square masses and exported as manure for rice fields. There we saw many Ainos at work with Japanese, but usually they prefer to work in companies by themselves.

From Ya-ma Koosh-nai we travelled five miles to Urope, a village of three or four Japanese, and about twenty Aino houses. The latter were scattered irregularly near the shore over a broad belt of sand, that has been drifted back by the easterly winds. They all have the same rectangular form, and are similarly situated in respect to the shore.

The best are composed of a house part about thirty feet long and twenty broad. To this is attached a porch about twelve feet long and eight broad, and around the whole is a straw fence. The house and porch are built of a frame-work of small poles fastened together with strips of bark and covered with millet straw. The walls are about four feet high and slightly sloping. The roof projects a few inches at the eaves and rises from each side to a point in the center. In the walls, under the eaves, there are two or three holes a foot in diameter, which serve as windows. In entering, you pass through the straw fence into the porch, and thence through a door into the house. The house part is generally one room, and also the porch; but in a few, a kind of partition is made in the larger room by hanging up mats. Most of the houses have no floors, but instead the sand is covered with mats of coarse straw, and on one side of the room there is a platform of boards on stones or blocks of wood, where the occupants lounge and sleep. They usually sit on the mats on the sand. In the center of the room the fire is made on the sand, and over this and about three feet above it, is a kind of frame-work held up by strings from the rafters, where they place the fish they wish to smoke. It also serves for a cupboard or dresser, where the smaller iron pans and kettles may be put away. There is no chimney, and I did not even see a hole in the roof for the smoke to escape. Everything overhead is, therefore, black with smoke, and generally has a shining, oily appearance. Each house is provided with a few iron pans and kettles of Japanese manufacture, and these, with two or three wooden dippers, and some large valves of the pecten, comprise their cooking utensils. They make a fire by means of a flint, steel and tinder, which are usually kept in a bag of undressed deer skin. In several houses I saw a considerable number of lacquered dishes, which they had evidently obtained from the Japanese. Near each house there is another small one about eight feet square, perched on a platform five or six feet high, in which they store their fish, in much the same way as the natives of Sumatra preserve their rice. In the first house we entered, the man was seated cross-legged in one corner making spears, with a fire of charcoal and a Japanese bellows. The woman was crouched near the fire, twisting up thin strips of the inner layer of the bark of a tree into a continuous line of the size of a mackerel line. It is from such material, and in this way, that all the lines for their fishing nets are made. They had four children; all boys, the youngest two and the eldest ten. The two younger ones had no clothing on whatever, and the other two were only provided with a long jacket, though it was quite chilly. With such exposure evidently a large proportion of their children must perish.

In the next house we entered—the dimensions of which I have given above as a model—we found an old man, his son, and three women. The old man said he was seventy-five, and his white hair and white beard made it appear probable, yet a young woman, apparently of twenty, was presented to me as his wife. She was demurely at work in one corner, making a straw mat after the Japanese style. The other young woman was weaving a piece of cloth about ten inches wide, from strings made of bark as already described. These strings, which represented the warp, were fastened at one end to a post and at the other end to a board which she kept leaning against while she changed them and pushed through the filling and pressed it down with a sharp edged board. This kind of cloth seems to be the only one they have, and it is all made in this slow and laborious manner. In front of this house, that is, on the side toward the shore, there was a kind of rack filled with sticks, each having on its top the skull of a bear. In this single place I counted twenty-nine skulls of this animal, a number that must make our old friend and his son rank high in the estimation of his Aino companions. In another house we entered, we found a man and his wife seated by the fire. The woman was sewing, but the man was doing nothing, and yet the bay was swarming with fish. He showed us the bow he used in hunting the bear, but would only sell a model of it, declaring that in their estimation it was most disgraceful for an Aino to part with the bow he was accustomed to use. However I secured a real arrow. The after part of the shaft was of reed, the fore part of solid wood to make it fly point foremost, and the barbed part of bamboo. They carry short knives, but they appear to rely on their bows and arrows when they attack a bear or kill a deer. I saw no lances, nor any implements of stone or bronze. I also purchased of this man a pair of snow shoes, each made of two strips of wood bent like an ox bow, with the straight part fastened together with deer skin. The woman sold me a short knife, with a scabbard of wood and ivory, rudely chased. It was the only piece of ornamented work I saw. As I was anxious to ascertain the height, the distance round the chest, and the length of the arm, hand, and foot of an Aino woman, my interpreter bribed the husband with a small piece of silver to make the desired measurements, but the paper was unfortunately lost, and now I can only state from memory, that the peculiarity which struck me most was, that the regions of the waist and chest did not appear as separate as in most women; but it remains to be seen whether this is a permanent character. The mammæ were very largely developed, and gourd-shaped.

When a woman marries they tattoo her upper lip and sometimes the under one also. A favorite pattern has the ends curved up, in just the way exquisites sometimes curl up the ends of their moustaches. Several times I inquired, what was the cause or origin of this strange custom, but invariably received the unsatisfactory answer—"because it is the Aino fashion"—which is, perhaps, as good a reason as could be assigned for a thousand foolish customs in the most civilized lands. At all events it gives these Aino women the appearance of trying to add to their charms by artificially making up for what they seem to consider a defect in nature's handiwork. The women also tattoo the backs of their hands in narrow transverse bands, but no other parts of the body. They never blacken their teeth, or compress the feet. In each Aino village, the oldest man, or a very old man, is the chief, and he in turn is responsible to a Japanese official styled "the Aino Interpreter." As the chief was away fishing, we called on the Interpreter, who was also absent, but a sub-official gave me some farther items in regard to the strange people under his charge. They cultivate millet and potatoes, but no rice. In one hut I saw the thick midrib of some wild plant finely chopped. When they kill a bear, they are allowed the head, but the skin belongs to the Interpreter. They are permitted however to wear deer skin, and the woman I saw first at Mori had on an outer dress of that kind. It is said that when young cubs are found they are brought home and nursed by the Aino women like their own children, but this is quite incredible.

Returning to Ya-ma Koosh-nai, I continued on to Mori, and made that day twenty-five miles over the sand, rocks and shingle. The next day I reached Hakodadi, thirty-two miles—whole distance on foot in six days, one hundred and thirty miles. On my return I found that eight Ainos had just arrived in a couple of junks from a place on the south coast, a short distance east of Endermo Bay. With the prospect of a small present they readily came to the residence of Colonel Rice, whose kind hospitality I was then enjoying. They all sat down cross-legged, in the Turkish style, not in a semi-circle like our American Indians, but in a straight line, the oldest man on their extreme left, the highest position of honor, and the rest arranging themselves according to their ages, to the youngest on their right. They could not tell, however, how old they were, but said that the Japanese officials kept a record of their ages. As soon as they were seated they began their salutation, which consists in slightly inclining the body forward, at the same time raising both hands as high as the eyes, with the palms inward and the fingers extended and nearly touching each other. The hands then pass down along the beard to the chest. This is repeated three times, and when they wish to show still greater respect they accompany these motions with a low guttural muttering. Saki (Japanese rice-whiskey) being their favorite drink, each was offered a glass and a chop stick. Taking the glass in the left hand and the stick in the right, they dip the end of the stick into the liquor they are about to drink, and slightly raising it describe a circle with an upward and inward motion. While describing these motions with the stick, they uttered a long prayer, in a low monotonous tone. This prayer, they afterward informed us, was not in our behalf, in return for the saki, but addressed to the god of the sea, asking that they might be preserved in their boats, and find an abundance of fish. One of their number spoke Japanese fluently, and Mr. James J. Enslie, the Japanese interpreter at the British Consulate, and himself the author of two interesting papers on the Ainos, kindly volunteered to ask them a list of questions I had prepared. In this way the following information was obtained directly from the Ainos themselves. As some of the questions proved quite perplexing, they became tired before the list was completed, and I failed therefore to get replies to all my queries.

They have many gods, but fire—not the sun, the moon, nor the stars—is the principal one, and they are accustomed to pray to it in general terms, for all they may need. They do not buy their wives, but are expected to make presents to her parents of saki, tobacco, and fish. At their marriages they make no great rejoicing or display. Their only feast is at the beginning of the new year, when they make offerings to all the gods. When a wife dies they burn the house in which she lived, but when a man dies they bury him without any funeral ceremony (perhaps the Interpreter meant if he was a common man). To inter a body they dig a hole in the ground and lay in planks in the form of a box. The body is then clothed in *white*, and placed in at full length, with the head to the east, "because that is where the sun rises." A widower may marry again in two or three years, but a woman can only marry once. (This the Interpreter probably intended to say was their law but not the universal custom.) A man can have only one acknowledged wife, but any number of concubines, each of whom always lives in a separate house. At present they have no king, but a great chief living at Saru. The Interpreter had met other Ainos whom he could not understand (that is to say, there are at least two different dialects in the Aino language). They keep no cats but catch rats in traps. They have "only Japanese horses." They keep fowls but no ducks. They eat their fowls and what wild birds they can take, but never eat *eggs*. They have no special burying grounds, and they desire only to forget their deceased relatives as soon as possible. The never speak of the dead, and if a man should call on a friend, and inquire for his deceased wife and say "Oh! is she dead?" such an act would be considered the grossest breach of good breeding. They say that they can make poison, but refused to tell how, and further declared that they kept it such a secret that even the Japanese officials knew nothing of the process. They have sorcerers whose advice they are accustomed to ask. A Japanese doctor who had lived long among them told me that when a man was lost at sea or among the mountains, his wife cries, and all her neighbors beat her with sticks to make her forget her sorrow. When the Interpreter was asked what would become of him after he died he replied he did not know, and when he was asked if he expected to go to a place of happiness or a place of misery, hereafter, he simply laughed as if he did not understand the question or thought it extremely foolish. They have no written characters, and only oral traditions.

After this questioning, I took the following measurements of two of them and add those of a man seen at Mori :—

	No. 1.	No. 2.	No. 3.
Height,	5 ft. 1¾ in.	5 ft. 2 in.	
Distance horizontally round the head just above the eyebrows,	1 " 10¾ "	1 " 10 "	
Distance round the chest immediately beneath the arms,	2 " 10 "	2 " 10½ "	2 ft. 10⅝ in.
Distance round the abdomen at the navel,	2 " 7½ "	2 " 9¼ "	
Length of the arm to the middle finger,	2 " 2½ "	2 " 4½ "	2 " 1¾ "
Distance round the arm at the largest part,	10¼ "	10¼ "	
Distance round the forearm at the largest part,	10⅛ "	10⅝ "	
Distance round the leg at the calf,	12½ "	12½ "	
" " " foot vertically,	10⅛ "	10 "	
Length of the foot,	9½ "	9⅞ "	

These measurements were made from men of medium size. They show, therefore, that although the Ainos are stout and strong, they are hardly taller than the Japanese, and not near as tall as the average of the people in the north of China. The relative size of the hands and feet to the rest of the body seems to vary considerably. I saw no lame persons and but one man who complained of being ill, though several had evidently reached an advanced age.

One of their chief peculiarities is the great development of their hair, not only the head and face, but over the whole body. Their eyebrows and eyelashes are very thick, and like their beards and hair, always of a jet black, till past middle life, when, as with us, they change to gray and in extreme old age to white. Their hair appears coarse compared with ours or with that of the Japanese. They wear it long—down to the shoulders. The men wear theirs as long, or longer than is the custom with their women. Their eyelids are *horizontal* and open *widely*, as in the Indo-European races, and are not *oblique*, and open but *partially* as in the Mongols, Manchus, Chinese, Japanese, and also the Coreans, all of which peoples it has been my privilege to see in large numbers. Their eyes are bright and sparkling and always black. The fine development of their chests, with their full heavy beards, gives them the appearance of noble and hardy men as compared with their effeminate Japanese rulers. They seem to be endowed with great vitality, and the fact that they so successfully resisted the repeated attacks of a more enlightened race for eighteen hundred years, sufficiently proves their daring and perseverance.

The dress of the men consists of a strip of cloth covering the loins in the same way as is customary among coolies in the East. In summer this is their only clothing, but in winter they wear long, loose coats, or dressing gowns woven from strings of bark. This is folded over from right to left* and bound at the waist with a sash. Their heads, feet, and legs are usually bare. The women have a shorter dressing gown coming down to the hips, and beneath this a piece of cloth wrapped around the waist and hanging down nearly to the knee.

As they have no written records, the earliest accounts of this people have come down to us through Japanese histories. According to a Japanese chronology compiled from the best sources and kindly translated for me by Father Nicholai, for the Russian Legation, Jin-mu the first Japanese emperor appeared on Kiusiu at Hunga (or Hewng-nga) in B. C. 667. In B. C. 663 he first came to Niphon, but was defeated and driven back by the aborigines. In B. C. 660 he returned and effected a permanent settlement on the southeast part of that island. In most of the Japanese histories, at least, no mention appears of the arrival of any new people, and the Japanese all believe that these aborigines were the ancestors of the present Ainos. Thus, this people, although so little known to this day, are mentioned half a century before the time of Nebuchadnezzar, and *six hundred* years before the northern and western parts of Europe were first described by Cæsar in his Commentaries, and more than *two thousand one hundred* years before the discovery of the continent by Columbus. In A. D. 272 the Ainos, for the first time, brought presents to the Japanese authorities and acknowledged them as their rulers. In A. D. 352 they rebelled, and in the year 366 they defeated the Japanese and killed their general. During the next two centuries, however, they appear to have been completely subjugated; for an educated Japanese informs me that as early as A. D. 655, the Japanese sovereign then reigning established a kind of government over the Ainos in Yesso, which was located near Siribets, a volcano on the north shore of Volcano Bay. In A. D. 1186, Yoritomo usurped the ruling power in Niphon, and becoming jealous of his brother Yosi Tsunay, had him put to death according to history, at a headland on the east coast, now called Shendai. But according to tradition, Yosi Tsunai escaped to Yesso, and treating the Ainos here with the greatest kindness, was deified by them and is now their chief hero.

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* This is the manner in which the Japanese females fold their dresses. The Japanese men fold theirs from left to right.

Although the Ainos had long been conquered by the Japanese, some of them yet lived on Niphon till about two hundred years ago, when they were all banished to Yesso. The same educated Japanese informs me that up to a short time ago, the ruins of a rude fortification, probably made by the Ainos, were to be seen at Nambu point, the most northeastern part of Niphon; and that similar ruins are reported to still exist among the mountains in the northern parts of that island. In Yesso, some ruins of a rude kind are reported at Saru, a village on the south coast, in the longitude of Cape Yesan at the entrance of Tsugar Strait; and—as the Aino interpreter previously said—the chief descendant of the old Aino kings (and therefore their chief prince) is now living at that place, and claims to possess some of the presents made by Yosi Tsunay to his ancestors.

In their eyelids which are horizontal and open widely, in the abundance of their hair, and in the full development of their chests, these people differ totally from the Chinese, the Japanese, and the Coreans on the south, the Manchus on the west, and the Gilyaks and Kamtschadales on the north; but in these same characters they call to mind the bearded peasants in Russia of the Slavonian branch of the Aryan family.

Are they, therefore, an extreme branch of the North Turanian family, or, as is more probable, in the same manner that the Indo-European races migrated from the high plateau of Central Asia through the plateau of Iran to the west, and the Persians and Indians to the south, did another part of that same family pass on to the east until they finally reached the islands now forming the Empire of Japan; and do their living representatives now appear before us in the persons of this isolated and ancient people, the Ainos?

ART. XXXIX.—*The Ainos, or Hairy Men, of Saghalien and the Kúrile Islands;* by ALBERT S. BICKMORE, A.M.

[Read before the Boston Society of Natural History, March 4, 1868.]

LAST spring, while at Hakodadi in the southern part of the island of Yesso, I forwarded to the Society a short paper containing some observations on the Ainos living on Volcano Bay. It was my determination at that time to go north along the whole western coast of Yesso to La Pérouse Strait, and crossing that in some junk, make my way up along the western shore of Saghalien to the Russian posts, if the Japanese government would allow me to undertake such a journey, but this privilege they would not grant. I therefore most gladly accepted a kind proposition from Capt. Susloff, of the Russian man-of-war Morse, to take passage with him up the Gulf of Tartary to the mouth of the Amoor.

Immediately after the date of the communication referred to, June 1st, 1867, we steamed out of Tsugar Strait for the opposite coast of Manchuria. A pleasant passage over the Japan Sea brought us to Vladi Vostock, the extremity of the great empire of Russia toward the east. Thence, our course was northeast to Kusyunai on the western coast of Saghalien, in about lat. 48° N. At this small post there was only a lieutenant, a doctor, and a few soldiers. Their log houses were back of a sandy beach on a low meadow, through which coursed a small stream. This stream had been the boundary between Russia and Japan up to the time of our arrival; but when we came to the Amoor, we found that a treaty had already been made between the two powers, to hold all the Kurile Islands (or all but one of those Islands), and the southern part of Saghalien, "in common."

At Kusunai I had the privilege of seeing a few of the Ainos of Saghalien. In their features, in their customs, and in every respect, they appeared to agree perfectly with those I had seen on the shores of Volcano Bay, and others who came to Hakodadi from the south coast of Yesso east of Endermo Bay.

Their huts were across the stream a short distance to the south, and we remained so short a time I was unable to visit them.

Whittingham,* who landed north of Cape Lamanon, and but a few miles from this place, thus describes the houses he saw there: "As we came near the shore, four dark men, with very long black hair flying in the wind, and clothed in seal-skin jackets, kilts and boots, waved their arms and hands, warning us to another landing-place, toward which they waddled with a peculiar clumsy gait. With many demonstrations of respect they led the way to their huts of rough logs, covered and the interstices filled with birch bark and dry leaves; they were low on the ground, and could only be entered by stooping on the hands and knees. The larger huts were used as store-houses for their fishing apparatus. One of the men was a magnificent savage, tall, lithe, straight and strong, with hair, beard and moustaches never desecrated by the touch of the scissors; with a high broad brow, dark eyes, straight nose and oval face, he was a far nobler creature than the Red Indian, who I had always fancied was the pride of wild men. His fellows were less manly in their bearing and smaller; and as far as dirt, mal-odor, and want of light permitted me to see, the women were ugly and little." The *oval* form of the face, which is here noticed, is very correct; but he is mistaken, however, about the stature of the women, which, in those I saw, was nearly equal to that of the men. I measured one man and found his height to be 5 feet 3¾ inches, nearly two inches taller than those I measured in Yesso. The distance round his chest was 3 feet 2 inches; stretch of arms across the chest, 5 feet 8¾ inches; length of arm, 1 foot 2 inches; and of fore-arm, 1 foot 6 inches; distance round the arm at the biceps, 10 inches; round the calf of the leg, 12¾ inches; and round the hand, when open, 7 inches. One of these aborigines had a remarkably large head, a light almost florid complexion, and such regular European features, that we all remarked that if he were to be clothed in European costume and transported to the western world, no one would imagine that he was a native of the northeastern part of Asia. Rollin in La Pérouse's voyage gives the following valuable measurements of the head of one of these people: circumference, 23·80 inches; its longest diameter, 10·30, and its shortest diameter, 6·83 inches. This shows their full cerebral development. Unlike those Mr. Whittingham describes, all the Ainos that I saw had cut off the hair on the front part of the head in the same manner as is the custom with the Japanese. Whether they were obliged to do this by their Japanese masters as a token of their submission, I was not able to learn. On Yesso some do and some do not cut off a part of their hair, and this is said to be the case on those Kurile Islands that have long been under the Russian government, and where the Japanese officials could not compel these people to follow their peculiar fashion.

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* Notes on the Expedition against the Settlements in Eastern Siberia. London, 1856.

During my stay at Nicholaifsk, at the mouth of the Amoor river, I met a Cossack who had been sent down to this part of Saghalien to live among this people in order to learn their customs and acquire their language. He gave me the following information in regard to that part of them that live on that island: The Aino name for Saghalien is Karapto They have no written characters, but the old men can send intelligence to each other by means of sticks notched in different manners. They are superstitiously afraid of the Japanese, and believe that they have supernatural power to injure them, and can at pleasure cause them to sicken and even die. When a man dies they bury him clad, not necessarily in white, but in the best suit he may happen to have, and usually in furs when he possesses any. The bodies of persons of all ages are placed at full length in boxes, with the face upward. At such times they all cry and mourn very bitterly, even to the children. The Cossack said that one time he wanted a little child that was visiting her parents, and when he came to their house he found her crying with the others over the loss of a friend. When a widow laments, they do not beat her with sticks as a Japanese doctor reported to me was the custom of the Ainos on Volcano Bay. Every friend who comes to mourn with a widow is very careful not to mention her husband's name, not from any superstitious fear of the dead, but for fear of reminding her of her loss, and thus adding to her sorrow. When a man dies, the next youngest brother takes the widow as his wife, either for life or until she has an opportunity to marry again. A widower may marry again in a month, but a widow is expected to remain single somewhat longer. They have no marriage ceremonies. A man does not buy his wife but works for her father. A man may have two or three wives; the Cossack did not know any man who had more than three. (The Gilyaks, their immediate neighbors, usually have two.) If a woman is unfaithful, the husband merely reproves her, and if no one but he and the guilty parties knew of it, he would probably not mention it to any one. When a woman is in labor, she remains with the other members of the family, but is kept from her husband for one month afterward.

They reckon time by twelve moons or months, and three seasons: when the snow melts, when the flowers appear, and when they fade. When any one is sick they sacrifice a dog on the top of a mountain—the higher the mountain the more they reverence it. The Cossack thinks that they believe in a Supreme Being, and that they only pray to the mountain to intercede for them with this exalted Deity. They are naturally a very reverential people, and do worship the sun, the moon, and the stars, but only as intercessors, according to the Cossack. (Their religion may be regarded as a modified form of Shamanism).

They keep dogs to travel with in winter and also use them for food. They have no cattle, and do not cultivate the soil, but the Cossack thinks that they would, if they were taught to do so, because they are not lazy like the Gilyaks (and every other branch of the Mongolian family).

They eat a kind of wild root as we do the potato, but they never cultivate it. They eat eggs. The Japanese have introduced cats among them. They have no mice, but thousands of rats, which they catch in traps, but not for food like the Chinese. The Cossack believes that they were never guilty of stealing before they learned the habit from the Japanese! For a theft, a man is fined, but such offence rarely occurs. Their women do not suckle young cubs as has been asserted on doubtful authority of the Aino women of Yesso. When the bears are grown, they kill them and eat them, and have a great feast. They do not worship the bear, but merely raise him and kill him in order to make a festive occasion.

Formerly they used implements of stone and bone—those of the former until quite lately. Now they have iron, but probably do not know how to get it from the earth themselves.

In regard to their origin, every village gives a different legend.*

What the Cossack has said in respect to their raising and killing the bear is exactly true of the Gilyaks as they represented their customs and notions to me.

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* The southern half of the peninsula of Kamtschatka is occupied by the *Kamtschadales*, also called *Itulms;* and the northern half by the Koriaks. The very northeast corner of Asia is the territory of the Tchuktchis. The following habits of the Koriaks and Tchuktchis, compiled from Mr. Pauly's great work, will show the similarity of the customs of those peoples with the customs of the Ainos given above:—

The Koriak women tattoo themselves, because "they hope in this way to repair the ravages of time." When a Koriak will marry, he must bring presents to his expected father-in-law, and if these are accepted, he must also enter into the lowest service for his new parent, such as tending the reindeer or bringing wood. He never speaks to the young lady, and moreover she is allowed no voice in the matter whatever. If the young man pleases the father, he gives him his daughter, and a recompense for his labor, which is sometimes continued for *ten* years.

The number of this people on Saghalien was very carefully ascertained in the year 1857 by Lieut. Rudanovsky, who was sent here by the Russian government for that special purpose. The locations of the villages and the number of houses or "yurts," and the population they contained, are given as follows in a newspaper published at Nicholaifsk at that time :—

On Aniwa Bay, east shore,	in 25	villages,	91	yurts, and	535	persons.
" " " west "	" 10	"	46	" "	143	"
" the Ohkotsk shore,	" 22	"	64	" "	473	"
" " coast of the Gulf of Tartary,	" 35	"	129	" "	1,268	"
In the middle of the island along a river,	" 3	"	10	" "	60	"

Total on Saghalien, 95 villages, 350 yurts, and 2,479 persons.

As these people subsist almost solely by fishing, I judge that there are not more than three or four times this number on Yesso and the Kurile Islands. This would make their total population from 10,000 to 12,000. Those given above as on "Ohkotsk shore," live on the northern extremity of Saghalien, along the bay between Cape Elizabeth and Cape Maria. All the central part of Saghalien is occupied by the Orochi, who live in the higher and more mountainous parts, and the Gilyaks along a part of both the eastern and western shores.

The isolated fragment of this people at the northern part of Saghalien is very interesting, because it indicates at once, that the Ainos were the aboriginal inhabitants of the island, and that the Orochi and the Gilyaks have come over from the continent at a later period, across "the Liman" or narrow strait between 52° and 53° 30′ north.

A line drawn along the high land from Cape Patience on the east coast around the head of the gulf of that name, and thence northwest to the village of Pilyavo on the Gulf of Tartary in about 50° 10′ N., would be the northern limit of the area these people usually occupy in the southern part of Saghalien. Occasionally, however, they go northward on trading

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If the father does not fancy the proposer, he is discharged and gets no recompense for his long, tedious toil. When he receives his wife, one more apartment is made in the yurt, and his future parents and neighbors beat him with sticks. If he endures this manfully, he proves his ability "to bear up against all the ills of life," and is then conducted without farther ceremony to the apartment of his betrothed. Polygamy is allowed, but all of the foregoing formalities are not observed, especially if the man is rich. They believe in an existence hereafter much like that of the present.

The Tchuktchis allow polygamy, but do not pay the *kalym* (a price for the bride). When a young man wishes to marry, he goes to the father and gets his favor, and tends his reindeer; and after having served for a short time in this capacity, he is married if the young lady consents. The rich get their wives without serving the bride's father, and often without paying a *kalym*. The lady chosen is usually a *cousin*. Divorce is frequent, on account of disputes between the husband and his wife, or trouble between the wife and her mother-in-law.

or hunting excursions in winter to the Tymy river, which flows eastward and empties into the Ohkotsk Sea in latitude 50° 50' N. Though I took much pains to inquire at Vladi Vostock and at Castries Bay of those persons who have been along the whole coast of Manchuria, I could obtain no indication that there is a single Aino now living on the continent. Afterward, while ascending the Amoor and the Usuri, I met fur traders who had passed to and fro over all the area between those rivers and the sea-coast, and they all confirmed this statement. The people at Castries Bay, described by Mr. Rollin in La Pérouse's voyage, were probably Gilyaks, the same people who live there now. The fact that the Ainos, unlike the Gilyaks and the Tungusic tribes, prefer to remain quietly near their homes, makes Rollin's statement improbable, and the error he made appears to have been repeated by nearly every ethnologist down to the present day.

Besides all the great island of Yesso, and the parts of Saghalien described above, these aborigines certainly inhabit all the Kurile Islands from Yesso to Paramushir, the next island but one to Kamtschatka, and according to some authorities, the extreme southern part of that peninsula also.

The earliest notice of this people by the Japanese historians has already been given in the previous paper, as occurring as early as 663 B. C., *more than half a century before the time of Nebuchadnezzar.*

The first European who has mentioned them in his writings was Père Aloisius Froes, in a letter dated at Miako, the capital of the spiritual emperor, March 1st, 1565 (twenty-two years after the discovery of Japan by the Portuguese). He thus describes this people,* though he does not give us to understand that he had ever seen them: "In the north of Japan, three hundred *leucas* (about 17 degrees), lies an extensive province inhabited by savage people. They are clothed with skins, are hairy all over the body, have terribly long beards, and very long moustaches, which they lift up with a small stick when they wish to drink. They are fond of strong drinks, are bold in war, and much feared by the Japanese. If they are wounded in battle they wash their wounds with salt water; this is their only remedy. It is said that they carry a mirror on the breast. They bind swords to the head in such a manner that the handle hangs down on the shoulder. (They now carry all bundles on their backs with a strap passing around the forehead.) They have no religion; it seems that they are used to pray to heaven."

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* Elucidations of De Vries' Voyage by Von Siebold, p. 98.

The next account of this hairy people appears in a letter from the Jesuit, Père Hieronymus de Angelis, written in Japan in 1622, a year before he was burnt at Yedo.* In the year 1620 he reached Saghalien, according to Krusenstern, and was probably the first European who had made his way so far through the Japanese empire. As he not only saw the Ainos, but lived among them, his descriptions are authoritative.

"As for the appearance of the inhabitants, they are coarse and of larger stature than men generally are: more inclining in color to white than to brown. They wear long beards, sometimes down to the middle. They shave the hair of the forehead half off, so that they have no hair on the temples, but a good deal behind, and some wear it as long as the Japanese. In general, they have the ears bored, and have silver rings in them instead of pendants: those who have no silver run a flock of silk through the hole and let the ends hang down long. This is done both by men and women. The dress of both sexes is long, interwoven with silk, embroidered with ornaments of crosses or roses of the same stuff, large and small. Their stuffs are of silk, cotton or linen. For arms they employ arrows, bows, lances and swords, which last are not larger than an ordinary Japanese poker. Instead of armor they have coats of small planks fastened together, which is ridiculous to look at. They have poisoned arrows which give an incurable wound. They are very quarrelsome, though they seldom kill one another." (This last statement is the only one of the kind made by any writer; but it is mentioned in the Japanese history of Sintuism, that they were the more easily overcome, because they were divided into a number of separate and independent tribes.) "The lord of Matsmay assured me that the inhabitants of Yesso went to three islands not far distant from their country, the inhabitants of which had no beards and a very different language from those of Yesso, to purchase fish-skins, which they call *raccoon.* But he did not know whether those islands were to the south or north of Yesso." (These people who had "no beard" and had "fish-skins" to sell, were without doubt some of the Tungusic tribes, on the shores of the continent, or perhaps the Gilyaks, who at that time certainly inhabited the islands in Tugur Gulf north of the mouth of the Amoor, and who chiefly dress themselves in fish-skins now. The Tungus on the middle Amoor had probably been supplied with cotton stuffs from China for centuries before that date, A. D. 1565.)

"As to their knowledge of another world and of a future life, it is little or nothing. They have some sort of worship for the sun and moon as the two greatest lights; as also some mountain and sea devils (spirits); for as they mostly support themselves in the sea with fishing, they hope by these means to catch much, and never be in want of wood for fuel or building. They have neither bonzes, nor priests, nor temples, nor any place where they can come together to do anything for their salvation. None of them are able to read or write. Each one has his own lawful wife, or as some suppose, even two: though there are many who have concubines in the Chinese manner. A woman taken in adultery has the hair of her head shaved off, that she may thus be known; and the adulterer, or he with whom she has committed the crime, is deprived of his sword and of all his ornaments by the offended husband, or by his friends as often as they meet him."

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* *Witsen's "Noord-oost Tartarye,"* and Siebold's De Vries, p. 99.

At the present time no Aino carries a sword, and it is probable that the Japanese compelled them to deliver up all such weapons as tokens of their entire submission.

John Saris, who visited Yedo in 1613 as ambassador from the English Company, heard of these people and gathered some accounts of them from the Japanese. Also Françoys Caron, chief of the Dutch trade in Japan during 1639 and 1640, gives some notices of them.

In June, 1643, Capt. Vries, in command of the *Castricum*, sailed up past the eastern entrance of Tsugar Strait, and thence coasted along the eastern shores of Yesso, and anchored near Atseki. The Ainos then living there seemed to be independent of the Japanese, as they now are in the interior of the island. These people had their own forts, such as will probably be found hereafter among the independent tribes. They are thus described:[*]

"These forts were made as follows: on the mountain on which they were placed was a small road steep to climb, and round on the four sides palisades were placed of the height and length of 1½ man's length; within this stood two or three houses. There were large fir doors in the palisades with strong clamps; when they were closed, two stout bars were passed through the clamps and thus fastened to them. At two corners of these square placed palisades, a high scaffolding is made of fir planks, for a lookout; further, the palisades are well fastened together with cross bars."

In comparison to the present poor and wretched condition of these people under the severe rule of the Japanese, Capt. Vries gives us this picture of the arms worn by the natives of Aniwa Bay, while they were yet free. "Their arms are bows and

[*] Siebold's Elucidations of Capt. Vries' Voyage, p. 115.

arrows, together with a hanger, much like the Japanese, the blade *inlaid with a thin silver border*; they bear it with a girdle in the Persian manner; the quiver, with a band round the head, hanging on the right side."

"In both the Gulf of Patience and Aniwa Bay they were very desirous of *iron*, giving in exchange feathers and fur, knowing very ingeniously how to pack up the feathers of boxes."

"They offered me a fine otter-skin, for which I gave an old ax with which they were very glad. How much silver we might offer them they always preferred *iron* to *silver*. These people are very fond of silk stuffs, for which they offered furs and *silverwork* in abundance."

The only ornaments or articles of silver they have now are their earrings, which are made of a piece of silver wire about one-tenth of an inch in diameter. This is bent into a large ring about an inch and a half or two inches in diameter, and where the two ends are joined, a glass bead, generally of a blue color, is added. These they appear to prize very highly, for while I was examining one at Volcano Bay, the owner seemed greatly troubled for fear I should take it out and carry it away. Occasionally these rings are made of brass.

"Their bows are four or five feet long, of ash or elm, and the arrows about half a yard, very cleverly made with a small reed harpoon at the end, rubbed with black poison, so that whatever is wounded with it must immediately die."

"They have also traps which, being bent like a bow, there is a round hole made in the wood of the bow, in which they lay some bait; the birds, such as mews, eagles, snipes or ravens, coming to pick in it, or putting in their feet, the bow springs up and the bird is caught."

"Their dogs, taught to catch fish as naturally as can be imagined, lie in wait on the shore of the sea or the banks of the river, and release each other as if they were men, when one has been a certain time on the lookout. The rest of the dogs, in troops of ten or twelve, run along the stream, and when they see any movement of salmon, they rush into the water, swimming in a half moon. The salmon, alarmed, jump out of the water into places where there is little or no water, where they are seized by the dogs on the lookout, who bite off their heads and bring the bodies to their masters, and then return again to their post. This takes place at low water." He thus describes how those people whom he saw were accustomed to make fire: "They had their instruments for making fire with them; these were square planks with a hollow in them; then they have reeds into which is inserted a short stick; when they want to make fire, they put the short stick in the hollow and rub it between the hands, so that it turns round, and so being dipped in sulphur, they hold that to it and soon have burning fire."

In 1698 Kamtschatka became known to the Europeans, and fifteen years after a Cossack reached Kunashir, the twentieth island in the chain from the continent. In 1736 Spanberg left Petropaulski and visited the Kurile Islands, so-called from the Russian word kuril, "to smoke." After Spanberg's voyage these people were known as "the Kuriles" or "the Hairy Kuriles," and as early as 1764, a book was written by Krasheninicoff,* which contained a more minute and complete account of the appearance and habits of that part of this people than any work I am able to find. Their religion and character are thus described:

"They are as ignorant of a Deity as the Kamtschatdales. In their huts they have idols made of chips of wood, or shavings curiously curled. These idols they call *Ingool*, and are said to venerate in some degree, but whether as good or evil spirits I never could learn. They sacrifice to them the first animal which they catch; eating the flesh themselves, they hang up the skin before the image, and when they change their huts they leave the skin and idol there. If they make any dangerous voyage, they take their idol along with them; which, in case of imminent danger, they throw into the sea, expecting by this method to pacify the storm, and with this protection they think themselves safe in all their excursions." A similar account is given by Capt. Vries of the Ainos on the eastern coast of Yesso and the southern part of Saghalien. He says: "When they sit round a pond and drink, they first pour out a few drops in several places round about the pond, as if they sacrificed. They have some cut fir sticks with shavings hanging to them, which they stick into the earth in many places, and hang them to the walls in the houses. When any one among them is ill, they cut long shavings off these sticks, and wind them round the head and arms of the patient." These sticks Siebold thinks agree with the *Sinto* of the Japanese, and are symbols of divinities in their ancient religion. This history of the Kuriles also represents them as "more civilized than the neighboring people, being steady, honest and peaceable. They have a respect for old people, and an affection for each other, particularly their relatives. It is a pleasure to see with what hospitality they receive such as come to visit them from other islands. They have an extraordinary way of punishing adultery: the husband challenges the adulterer to a combat, which is performed in the following manner: both the combatants are stripped quite naked, and the challenger gives the challenged a club, about three feet long, and near as thick as one's arm; then the challenger is obliged to receive three strokes upon his back from the challenged, who then returns him the club and is visited in the same manner; this they perform three times, and the result is generally the death of both combatants. If any one prefers his safety to his honor, the adulterer then is obliged to pay the husband of the adulteress whatever he demands, whether in skins, clothes, provisions or other things. When twins are born they always destroy one. The men shave their heads as far back as the crown, allowing the other hair to grow to its full length. The women only cut the fore part of their hair, that it may not fall into their eyes. The lips of the men are blackened about the middle; the women's are entirely black, and stained round; their arms are likewise stained with different figures as far as the elbows. This custom they have in common with the Tchuktchi and Tungus. Their clothes are made of the skins of sea fowls, foxes, sea otters, and other animals; and are generally composed of the skins of very different creatures, so that it is rare to see a whole suit made of the same sort of skins."

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* History of Kamtschatka and the Kurilski Islands. Translated by James Greve. Lond., 1764.

Capt. Golovnin, in the memoirs of his captivity, informs us that he had a native with him from one of the northern of the Kurile Islands, and the evidence he is thus able to give in regard to the identity of the inhabitants of the Kurile Islands and those of Yesso, and to the similarity of their dialects, is very conclusive. He says: "The language of the inhabitants of all the Kurile Islands, except some tribes on the south part of Matsmai, is alike, with the exception of such words and the names of such things as the northern Kuriles first got from the Russians, and those of the south from the Japanese. Alexi (the Aino mentioned above), though he had difficulty in understanding them, yet it never happened that he did not comprehend them after some explanation; in a word, the languages of the inhabitants of Matsmai (another name for Yesso) and of the other Kurile Islands resemble each other much more than the Russian and Polish. The Kuriles of all the islands and Yesso call themselves Ainu (better Aino); but to distinguish the inhabitants of the different islands, including Matsmai, they add to every word the name of the island, as for example, Kunashir-Ainu, Iturup-Ainu, that is, the people of Kunashir, and the people of Iturup. When they see foreigners they call them Rusko, Russians, or Niponno, Japanese, as they know only these two nations." The only difference between the Ainos of Yesso and the Kuriles is, that the former are "handsomer, stronger, and more active" than the latter, and this difference Golovnin thinks is due to the former leading a more active life, and having a greater abundance of good food. "The northern Kuriles live in indigence, feed on roots, sea animals, and wild fowls, of which indeed they never want, but idleness often hinders them from collecting a proper stock."

To show how uniform are the customs of this people over Yesso, we may quote the following description of the Ainos at Romanazoff Bay, at the northern end of the island, near La Pérouse Strait, from Krusenstern's voyages: "We saw there only two fur dresses, and the rest of the people were dressed in a coarse yellow stuff made of the bark of a tree, which a few bordered with blue cloth. (In the cloth I saw them weaving at Volcano Bay they occasionally placed a few threads of blue cotton so as to give the whole a striped or checked appearance.) "Under this dress they had another of a fine cotton stuff that they had probably purchased from the Japanese. The Ainos of Yesso (which was at that time under the Japanese) were much poorer than those of Saghalien (which, a short time before, had become a part of the Japanese Empire). The women wore no ornaments on their heads, but as I have already mentioned, they invariably paint their lips blue. The men wore earrings, which were commonly merely a brass ring. At this place we visited two abodes which consisted of a single large room, which, with a small division at one end, occupied the whole interior of the house. Their construction did not seem to me very solid, and I cannot conceive how they are able to bear the cold, which must be very intense here in winter. In the middle of the room was a large hearth, around which the whole family, consisting of eight or ten persons, was seated. The furniture consisted of a large bed, over which a Japanese mat was spread, and several boxes and barrels. All their utensils were of Japanese manufacture, and mostly lacquered: it appeared from the interior of the house that the inhabitants possessed a degree of affluence, such as is not found among the Kamtschadales, still less among the Aleuti and the unfortunate inhabitants of Kodiack. Fish is probably their only nourishment, their houses on this account being chiefly scattered along the shores. We perceived no symptoms of cultivation, not even any plantations of vegetables, nor did we see any tame fowls or domestic animals, except dogs, which they had in great abundance."

The first full description of the features of this people was given by M. Rollin in La Pérouse's voyage in 1787, and as it seems to be what has been constantly copied by all ethnolo-ogists, I give a translation in full. The natives described were seen at the bay of Langle, on the west coast of Saghalien. "These people are very intelligent, respect property, and communicate freely with strangers. They are of moderate height, short, strongly built, have a *léger embonpoint*, and the forms of the muscles very marked. The most common height is five feet. The tallest are five feet four inches, but such men are very rare. They have large heads, and a large face more rounded than that of Europeans. Their countenances are animated, quite agreeable, although all the parts that compose the face do not have in general the regularity of ours. Nearly all have the cheeks large, the nose short and rounded at its extremity, and the nostrils very thick; the eyes sparkling and *bien fendus*, of medium size, sometimes blue but generally black; the eyebrows heavy; the mouth medium; the voice strong; the lips somewhat thick and of a dark color. Some individuals have the upper lip tattooed with blue; these parts, also their eyes, are capable of expressing every kind of sentiment. They have beautiful teeth, very regular, and of the ordinary number, the chin rounded and slightly salient, the ears small; these they pierce in the lower part, and wear ornaments of glass or silver rings."

Although this description of their features is certainly the most complete and the most accurate that I have been able to find in any work, yet it fails to mention their two most important characters, already noticed in my previous paper, to wit: first, that their eyelids are *horizontal* and open *widely*, and are not *oblique* and open but *partially*, as in all the Mongol family; and secondly, that their cheek bones are *not* prominent. These two great characters, which are constant except in the descendants of those Japanese officials who take concubines from the Aino women, in my opinion, separate them from the whole Turanian family, where, so far as I am aware, every ethnologist has placed them, without adding even the slightest hint that their true position was in any degree doubtful.

These same characters show that hereafter they must be regarded as a branch of *our own Aryan family.** This view is strengthened by the wonderful development of their hair, which has generally been given as their most important characteristic. In this they agree with the bearded peasants of Russia, and approach the Slavonian branch of the Indo-European division of the Aryan family. Their nostrils are somewhat thick, but the nose is much more prominent than in any branch of the North Turanian family at least. This last character is not fully shown in the accompanying photographs, as they do not represent the head in profile.

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* Dr. Pickering, Curator in the Ethnological Department in the Society and Ethnologist on the U. S. Exploring Expedition, fully concurs with the view expressed above, and authorizes the addition of this note.

Latham, in the latest edition of his careful and extensive work, "Descriptive Ethnology," published in 1858, refers both the Ainos and Gilaks (Gilyaks) to one sub-group of the Turanian family, "the Kurilians." He further adds: "Mongol features are common, yet prominent noses and comparatively thick beards are by no means rare." The first character is true of all the Gilyaks, who are probably more nearly allied to the Kamtschadales, the Koriaks, the Tchuktchis and the Yukahiri, than they are to the neighboring Tungusic tribes on the Amoor. All these peoples are of pure Mongolian stock. The second and third characters mentioned by Mr. Latham, instead of being "by no means rare," are universally found among all the Ainos, whether those living on the Kurile Islands, on Yesso, or on Saghalien.

Von Siebold, who lived many years in Japan, and who enjoyed the best of opportunities for studying this people, in one of his last works, "Elucidations to the discoveries of Vries," London, 1859, speaks of this isolated and distinct people as "the Aino *tribe*," as if, instead of belonging to a different grand division of the human family, they merely formed but one of the many Turanian tribes in the northeastern parts of Asia, though widely separated from them.*

Even Mr. Pauly, in his great work published at Moscow, in celebration of the crowning of the present Czar of Russia, in 1855, refers them to a subdivision of the Turanian family, and includes in that subdivision the Gilyaks, the Kamtschadales, etc.

Not only do these people differ from all the Turanians in their *physique*, but in all their mental characteristics. Instead of being reserved and wily, like all the peoples of the Mongolian stock, they are most open-hearted and communicative. Instead of being of a roving character, they appear attached to their own country. Their mild and generous dispositions have been especially noticed by every European who has ever seen them. Capt. Krusenstern thus minutely and graphically describes these characteristics: "Here (i. e. within their dwellings) was no loud talking, no immoderate laughter, and still less any disputing. The satisfaction that appeared in all their countenances as they spread their mats round the hearth for us; their readiness, when we were going away, to launch their canoes and carry us across the shallows to our boat, when they perceived our men stripping themselves for this purpose; but still more than this, their modesty never to demand anything, and even to accept with hesitation whatever we offered them,—wherein they differ very much from the inhabitants of the west of Saghalien (that is, from the Gilyaks),— these marks of their natural character make me consider the Ainos as the *best of all the people I have hitherto been acquainted with.*"

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* When the previous article was written I had not seen this view of Von Siebold.

The view herein expressed, that they form a member of our own family of nations, renders their language perhaps the most interesting of any that now remains uninvestigated, in the whole world. All that is known at present regarding it may be well summed up in these words of Von Siebold:

"The Japanese, who have had intercourse with the natives of Yesso for centuries, carried on trade with them, and ruled over them, have gradually made themselves thoroughly acquainted with their language, and composed dictionaries in which they sought to render as faithfully as possible, and to fix the pronunciation of the words by means of their syllable writing. In this manner they have endeavored, by means of writing, to put a stop to the manifold sounds and variable accent to which the dialect of a far dispersed and illiterate people is so subject." (This dictionary referred to was published in Japan in 1804, by Mogami Yoknai.)

"Although the Aino language has become ennobled by familiar intercourse with a civilized people (the Japanese), yet it has preserved its original features, and is characterized as a peculiar and independent language, having no connection with that of any of the neighboring countries, as far as regards the roots of the words. That some foreign words have been introduced from the northwest and northern nations (*Samoiedes*, *Tungus* and *Kamtschadales*) with whom the Ainos had intercourse, is not to be denied, any more than that they have naturalized many Japanese words, signifying objects and ideas formerly unknown to them. The Aino language, as the tribe itself, stands isolated from all the others of the northeast of Asia, for so far as they are yet known." This last sentence, so far from hinting that their nearest allies are to be found in Europe or Persia or Hindustan, at once suggests—if it contains any suggestion—that their nearest allies live in the southeastern parts of Asia. He continues: "The general rules, however, according to which the parts of speech are declined and conjugated, agree with those of their southern, northern and western neighbors, who write their language *syllabically* (as the Manchus, Mongols, Tibetans, Yakuts, etc.) and not *figuratively*, that is to say, using signs for words (as the Chinese)."

Here, then, we have an *Aryan* people speaking a *non-Aryan* language, and that language peculiarly their own; not learned from a people who have subjugated them, or from a people whom they have subjugated, at least within two thousand five hundred years!

At the close of the preceding paper I suggested, in the form of a question, that these people had migrated in the most ancient times from Central Asia. The fact that there is some reason to suppose that as early as 2,000 years before Christ there was "a settled government and society" in China, afterward suggested that this migration took place along the northern borders of the Mongolian desert, or the southern parts of Siberia, to the head-waters of the Amoor, and thence either down the Amoor to the island of Saghalien, or down the peninsula of Corea to the Japanese islands, or possibly in both of these directions, because the migrating stream of such a weak and undeveloped people as the Ainos now are and probably were at that time, would have been turned aside by a settled government as easily as a huge boulder turns aside a mountain brook. This view I now find has already been suggested by Von Siebold.

Professor Max Müller, judging from the evidence of grammatical structure, supposes there have been three great migrations from Central Asia toward the northern and northeastern parts of the continent. They are as follows: firstly, the ancestors of the present *Tungus*, along the Amoor and the Lena; secondly, the ancestors of the *Mongols*, in the region of the Altai mountains; and thirdly, the ancestors of the *Turks*, including the *Yakuts*.

In a similar manner, but perhaps centuries before the first of these three migrations, we may suppose the Ainos to have separated from the rest of the Aryan family and to have moved on toward the east till they reached the islands of Japan. The early date of this migration is indicated by the negative evidence, that as far as we are yet aware these people are not mentioned by the ancient historians of China as being ever found on the continent. The earliest notice of them appears "in the Han dynasty* (between 189 B. C. and 30 A D.), when the *Mao-mim*, whose bodies were covered with

* Von Siebold's Eluc. to Vries' Voyage, p. 122.

hair, are described as inhabiting *the other side* of the East Sea." This East Sea was probably the one we now call the sea of Japan. During the *Sui* dynasty (A. D. 608–622) a notice occurs of "the tribe *Mo-zin*, consisting of fifty hordes, living in the northwest of the land, Woke (Japan)."

That none of these people lived in the territories immediately tributary to China, in those early times, is proved by the fact, that in A. D. 659, the Japanese on one of their embassies to the court of that great empire took two Ainos with them to exhibit as *curiosities*.

This people are undoubtedly passing away. Even during the last century and a half that the northern of the Kurile chain has been a part of the Russian empire, their numbers on those islands have been ascertained to have greatly diminished, though the Russians have unquestionably treated such obedient subjects with the greatest kindness. The causes of this decrease are supposed to have been the ravages of the small pox, and the considerable numbers lost while crossing from island to island in their frail boats over those stormy seas.

On Yesso and Saghalien, where they have for several centuries continued under the merciless tyranny of the Japanese government, their numbers have probably diminished in still greater proportion. At Kusyunai, on the latter island, I was assured by a Russian officer that when some Ainos came there to escape from the Japanese and place themselves under the protection of the Russian government, and the official stationed there had refused to receive them for fear of complicating the two governments and had sent them back, the Japanese government "beheaded them to a man." A great diminution in their population must also have followed their forced removal from the large and fertile island of Japan to the comparatively sterile island of Yesso, and to the yet more rigorous climate of the Kuriles. Indeed, there is much reason to believe that if the enlightened nations of the western world had been a few centuries later in reaching that distant region of the east, these people would only have been known to us by a few passages in the writings of the Japanese historians, and even then all such references would probably have been regarded by careful investigators as apocryphal, and more properly classed with myths and fables.

Though they were, long ago, mostly subjugated by the Japanese, yet the tribes in the interior of Yesso continue independent down to the present time, and here, far removed from any influence of the Gilyaks, Kamtschadales and Russians on the north, the Manchus on the west, and the Japanese on the south, we may expect to find these people still retaining all the *ideas of their ancestors*, and practicing all their ancient customs.

ART. XL.—*On the existence of the Mastodon in the deep-lying gold placers of California;* by B. SILLIMAN.

DURING several visits to the gold regions of Tuolumne county, California, in the summer of 1867, I obtained evidence leading to the conclusion that the Mastodon, and perhaps the Elephant, existed prior to the great volcanic disturbances and outpourings of lava which occurred throughout the Sierra Nevada mountains pending or at the close of the epoch in which the deep-lying placers were produced.*

It is well known that this epoch of volcanic activity has been regarded as marking the period of the Pliocene, dividing it from the Post-Pliocene and existing epoch, by a well-marked horizon. Among the animals whose remains have been found in this ancient auriferous detritus of California, preceding the epoch of volcanic activity, are "the rhinoceros, an animal allied to the hippopotamus, an extinct species of horse, and a species allied to the camel and resembling the *Megalomĕryx* of Liedy."†

The remains of mastodon and elephant are found abundantly in the superficial detritus of the gold region, over an extended area, but until now they have never been certainly idenfied as occurring under the basalt, which covers the ancient gold drift and forms the highly characteristic ranges known as "Table Mountains."

Near Jamestown, a village in Tuolumne county, extensive explorations have been made during the past fourteen years, in the deep-lying gold detritus, by tunnels driven in beneath the basaltic capping, at a level low enough to open the bed of the ancient rivers, in the channels of which rests the gold-bearing gravel. These tunnels are from a few hundred feet in length to three thousand feet or more ("New York tunnel" 3,500 feet), and they are from two hundred to three hundred feet below the nearly level surface of the basalt. They are driven as nearly as possible at right angles to the supposed course of the ancient stream, and in order to drain off the water by gravity, the grade commences often 150 feet or more beneath the lip of the "rim rock" or margin of the old valley, aiming to come out in, or just beneath, the ancient channel or river bed. Underneath the basalt is a mass of stratified, almost horizontal, generally thin-bedded, detrital matter, alternating with clay and argillaceous zones, the thinly laminated beds containing often vegetable stems and impressions of leaves, indicating deposition in quiet water, while other portions are made up of coarse gravelly masses, compacted often into firm coherent "cement," as the miners call it. From the ancient river bed to the top of the basaltic capping of Table Mountain, is certainly not less than three hundred feet, probably somewhat more.

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* For a notice of the nature of these remarkable deposits, see a paper by the author, in this Journal for July, 1865 [II], xl.

† Geological survey of California, vol. I. (Geology) p. 251.

It is beneath this mass of matter, partly aqueous and partly volcanic in its origin, that the remains of mastodon herein mentioned have been found. My attention was first called to them by discovering the portion of an *os illium* in the collection of A. B. Preston, Esq., local Judge of Jamestown, which he assured me had been found in driving the so-called Humbug Tunnel under Table Mountain, at a point 1,500 feet in from its mouth. Associated with it was the point of a tusk, which I also secured. Both these specimens are now in the collection of the Peabody Museum at Yale. Although I obtained the the plainest possible testimony of eye witnesses to the fact that these bones were taken from beneath the basalt, I should not venture to mention the fact in support of the opinion that the mastodon existed in the Pliocene period, without farther and more satisfactory evidence.

This I was fortunate enough to obtain from Mr. D. T. Hughes, now engaged in exploring a tunnel upon the southwest side of the same mountain, which was formerly known as the Maine Boy's Tunnel,* but now called after Mr. Hughes. Mr. H. informed me, that at a point about 1,600 feet in the tunnel named, bones existed, believed by him to be those of mastodon or elephant, and which had been uncovered some time since, but were at the time of my visit inaccessible, owing to the falling in of that portion of the work. I immediately visited the place, and made all the examination possible at the time, but could not then nor on a later occasion gain access to the bones. At my request explorations were resumed in the direction likely to uncover them, and I made arrangements to return to the locality whenever the miners should again reach these interesting remains, but up to the date of my leaving California (January, 1868), I was advised that this point had not yet been reached, and all I could do was to urge Mr. Hughes to use all diligence in the search and communicate to me by letter a full notice of the facts as they should develop themselves. On the 24th of March I had the pleasure of receiving from him the following letter.

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* For a section of the Maine Boy's Tunnel see Geological survey of California, Geology, vol. i, p. 249, where also, pp. 243–253, may be found a fuller account of the Table Mountain and accompanying phenomena, than our space permits us to give herewith.

Letter from D. T. Hughes to B. Silliman, dated Jeffersonville, February 22, 1868.

"In compliance with your desire that I should write to you whenever I should reach the bones, I have now to state that I have reached them at last, and I regret very much that you were not here to examine them as they lay. The bones were very much decayed, indeed so much so that I found it impossible to obtain any of them whole, with the exception of four grinders, which I have in a very good state of preservation. The remains of this large animal were found 1,650 feet in under the Table Mountain, and four and a half feet above the ledge or bottom slate, imbedded in a stratum of sand overlaying a deposit of gold-bearing gravel, and scattered over a space twenty feet long by ten or twelve feet wide. A large portion of these bones were so soft that I could penetrate right into them with my fingers, while other pieces were a little harder, and looked very interesting. Some of the cavities were lined with yellow iron pyrites, and so bright, that when first exposed to the light of the candles, they glitter like diamonds. I have numerous fragments of different bones which bear handling very well when thoroughly dried. The two tusks lay together, imbedded in the same stratum of sand, and very much decayed also. I endeavored to remove them entire, or in medium sized pieces, so that I could put them together again, but I was unsuccessful and found nothing that would hold them together. Both of the tusks were slightly curved, and large pieces of the points had been broken off, apparently. Each tusk measured, as I found them, seven feet and one inch in length, and if whole would probably have measured ten feet. They were not exactly round, measuring three feet from the end that enters the socket six inches in one diameter and five and a quarter inches in the other.

The grinders, as before mentioned, are in a very good state o preservation. The two posterior grinders each measure six inches in length and three and a half inches wide, and the two exterior measure each four and a half inches in length and two and three-fourths inches wide. The enamel on the posterior ones is very perfect, but the exterior grinders are very much worn, apparently. I found it impossible, because of their softness, to get the dimensions of any of the other bones, which I regretted very much.

Enclosed you will find a rough sketch of three of the teeth (with portions of the jaw attached.) The two grinders you see togther are in the same position as when I dug them out. The sketches are not drawn to an exact scale, but will convey an idea of the grinders as they are. The other drawing is the side view of the posterior grinder. * * * *

From Mr. Hughes' description and the accompanying drawings there is no room to doubt that the bones discovered are those of the mastodon, and it appears probable that nearly the entire skeleton of a full sized animal was entombed in the sands resting immediately upon the ancient auriferous gravel beneath the Table Mountains, and of course anterior in age to the period of volcanic activity and overflows of lava, which have hitherto been considered as marking the close of the Pliocene era, a catastrophe which appears to have exterminated the other members of the Pliocene fauna.

If the mastodon survived the catastrophe which exterminated the hippopotamus, rhinoceros, tapir, &c., and continued through the Post Pliocene, to the appearance of man, it yet remains to be proved that man was his companion prior to the dawn of the existing epoch.

New Haven, March 25, 1868.

ART. XLI.—*Note upon the occurrence of fossil remains of the Tapir in California;* by WM. P. BLAKE.

The remains of Tapir occur in the auriferous gravel of Wood's creek, near Sonora in Tuolumne county, California. They were found by gold miners at a depth of about forty feet below the surface, and were presented to me by Dr. Snell of Sonora. A specimen submitted to Prof. Owen at the British Museum was recognized as the "crown of the left lower molar tooth of a tapir, and another specimen as the posterior epiphysis of the cervical vertebra of a hoofed animal, probably a young tapir." Numerous teeth of the Mastodon have been found in the same region, together with stone implements of various forms. Some of the latter, according to the statements of Dr. Snell, were taken from the deep placer deposits which underlie the lava of Table Mountain.

ART. XLII.—*Nitroglucose;* by M. CAREY LEA.

As nitroglucose has been much less studied than its congeneric nitro-substitution compounds pyroxyline, xyloidine and nitroglycerine, a few words on its preparation and properties may not be uninteresting.

The substitution does not take place in sugar with quite the same facility as with cellulose; the acids need to be stronger and the temperature lower. The sugar, moreover, appears at first to dissolve, and then to separate out again, in the form of a greyish paste, which, when thrown into water and freed from the adhering acid, becomes nearly white.

An attempt to prepare nitroglucose by the use of nitre and sulphuric acid, which succeeds so well and so easily in the case of cellulose, failed almost wholly with sugar. Not more than two or three per cent of the weight of the sugar was obtained.

With sulphuric and strong nitric acids, allowed to cool thoroughly after mixing, the reaction takes place easily, and a considerable quantity of nitroglucose is obtained. The nitric acid should be as strong as possible, and as the acid of the requisite strength is not easily obtained commercially, I have found an advantage in using in part the fuming sulphuric acid. Two fluid ounces of fuming sulphuric acid, two of common sulphuric, two of strong nitric acid, as near to 1·5 sp. gr. as can be obtained, give good results. The sugar is stirred in, in the form of powder, to a thin paste. The stirring is kept up, and as fast as the nitroglucose separates in doughy masses, it is removed with a spatula and thrown into cold water. A further addition of sugar will give more nitroglucose, but considerably less in proportion than the first addition. As soon as possible, the nitroglucose is to be kneaded up with cold water, to get the acid out. In one case, when this was neglected for ten or fifteen minutes, the nitroglucose passed to a greenish color and apparently was undergoing a commencing decomposition.

The removal of the adhering acid is much more difficult than in the case of pyroxylin, and is an extremely disagreeable operation. The acid pervades the whole of the doughy mass so fully, that the fingers are stained and burned by it, nor can the whole of the acid be removed satisfactorily in this way. The best means I found was to dissolve the crude nitroglucose in a mixture of alcohol and ether, and then to pour this into a large quantity of cold water with constant stirring, and violent agitation afterward. The method is not altogether satisfactory, and seems to be attended with some loss of material, though why, it is not easy to see.

Prepared in this way, nitroglucose is a white lustrous body, which may either assume the doughy amorphous condition or the crystalline, and passes from one to the other with extreme ease. When first formed by the mixed acids, it always has the doughy form. That which I obtained by the use of nitric and sulphuric acid, was crystalline from the first. When precipitated by water from its solution in alcohol and ether, it is doughy and almost liquid, and remains so for a long time, if there is any considerable quantity of it.

The best mode of preserving it appears to be under water. By standing thus it gradually hardens, and passes sometimes to a somewhat hard amorphous mass, and sometimes to a granular crystalline state. It appears to be wholly insoluble in water. A few minute grains of the crystalline form diffused through 15 or 20 ounces of water, did not dissolve after many hours standing. In a mixture of alcohol and ether it dissolves as easily as sugar in water, and in such quantity as to make the liquid syrupy.

Its detonating properties are but slight. If it be well dried and a match be applied, it deflagrates with a feeble flash.

It has been stated by Dr. V. Monckhover, that when dissolved in alcohol and kept sometime in a warm place, it undergoes decomposition, as evidenced by the fact that the solution then gives an abundant precipitate with nitrate of silver, which at first it did not do. An experiment made in this direction did not give the result thus indicated. A solution of nitroglucose in alcohol, containing about 40 grains to the ounce, was placed in a stoppered vial and was kept in the sand bath at a temperature of about blood heat for nearly a month. But neither it nor a fresh solution gave a precipitate with alcoholic solution of nitrate of silver. It would seem from this that certain conditions of temperature or otherwise are necessary, in order that this decomposition should take place.

ART. XLIII.—*On the action of Ferrocyanid of Potassium on Monochloracetic ether*; by O. LOEW, assistant in the Laboratory of the College of the City of New York.

KOLBE was the first to prepare cyanacetic acid, which is especially interesting from its transformation into malonic acid by treatment with potassa. In a similar manner Heintz prepared sulphocyanacetic acid, by boiling monochloracetic ether with sulphocyanid of potassium. This led me to try the action of ferrocyanid of potassium upon monochloracetic ether, to ascertain whether the radical ferrocyanogen can participate, as such, in the reaction. I boiled monochloracetic ether, dissolved in alcohol of 90 per cent, with powdered ferrocyanid of potassium for 4 to 6 hours. An action gradually took place, by which chlorid of potassium was formed, together with another light blue amorphous substance, which became of darker color on exposure to the air, and was undoubtedly Prussian blue.

When the liquid was filtered and boiled with caustic potassa, ammonia was developed; after the latter ceased to be evolved, the liquid was mixed with sulphuric acid and agitated with ether. On evaporating the ether I obtained white crystals, having the appearance of malonic acid. This substance was converted into the lead salt by precipitation with acetate of lead: 0·2997 grm. yielded 0·2904 grm. sulphate of lead =66·99 *per cent Pb.* The malonate of lead contains 66·99 per cent Pb.

The reaction is therefore not analogous to that above cited, but the radical ferrocyanogen is broken up into cyanid of potassium and cyanid of iron. The former yields, with chloracetic ether, chlorid of potassium and cyanacetic ether, while from the last named body malonic acid is produced.

New York, Nov. 26, 1867.

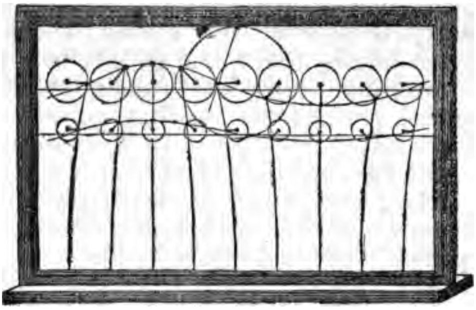
ART. XLIV.—*On C. S. Lyman's new form of Wave apparatus.*

THE theory of waves that has been generally taught since the days of Newton, is that which represents wave motion as consisting in the alternate rising and falling of the parts of a liquid in vertical lines, as in the two branches of a U-shaped tube; this is usually cited as Newton's theory of waves. There is to be found, indeed, in the *Principia*, the hypothesis of vertical oscillations, and also the cut of the bent tube, so persistently copied by subsequent writers; yet, it is evident that Newton adopted the hypothesis, rather as an expedient for a special purpose—that of finding approximately the relation of a wave's length to its period—than as strictly true to Nature; for he concludes his investigation with the remark:—"These things are true, upon the supposition that the parts of water ascend or descend in a right line; but, in truth, that ascent and descent is rather *performed in a circle* ("*verius fit per circulum*"); and therefore I propose the time defined by this Proposition as only near the truth." This important qualifying clause seems to have been quite overlooked by those who have professed to give Newton's theory of waves.

The modern theory—which teaches that, in wave motion, all the particles of a liquid are revolving synchronously in vertical circles—though so broadly hinted at by Newton himself as the true one, in the words italicised above, has nevertheless been developed, for the most part, only within the present century. It was first clearly stated and ably advocated by Gerstner in 1804. More recently, it has been satisfactorily established as accordant with observed facts and the laws of Mechanics, by the experimental researches of Weber and Scott Russell, and the mathematical investigations of Stokes, Rankine, and others. A concise exposition and demonstration of the theory may be found in a paper by Prof. Rankine, in the Philosophical Transactions for 1863. Though but just beginning to find its way sparingly into the text books, it has become the generally accepted theory among men of science; and having in reality supplanted the old hypothesis as an expression of scientific truth, there is no good reason why it should not also supplant *it*, in the lecture and recitation room.

In teaching this theory, however, it is often found difficult to make pupils understand, how the infinitude of simultaneous revolutions, which it supposes, can take place without mutual interference, and in such a way as to produce the observed phenomena. It was to obviate this difficulty, and illustrate, as far as practicable, the *modus operandi* in question, that the piece of mechanism was devised, which is the subject of this article. It presents to the eye, not merely the surface contour of a wave, with its undulatory motion—which, to some extent, other forms of wave apparatus also do—but, besides doing this in a more exact and satisfactory manner, it exhibits the motions also that are at the same time taking place below the surface, in the whole mass of liquid affected. This completeness of illustration is due to the circumstance, that in the apparatus, the elementary motions are the same, essentially, as in actual waves; hence, the leading points, geometrical and dynamical, of the theory of waves, are presented naturally, and in their true relations.

The construction of the apparatus will be readily understood from a brief description, and the accompanying cut.



In front of a plane surface are two series of revolving arms or cranks, the length of the lower ones being half that of the upper. Two elastic wires connect the crank-pins of each series; upright wires also connect each pair of cranks, and pass down through a plate into the base. The cranks all revolve synchronously; they thus keep their relative position, and come into any given position successively, each in its turn. The relative position of the cranks of each horizontal series is such, that the directions of any two, in regular order, differ by the same fraction of a whole revolution, that the distance between their axes is of a whole wave length. Thus, in the apparatus, the wave length is supposed to be divided into eight equal parts, and hence the common difference between the directions of adjacent crank arms is one eighth of a circle, as shown in the figure. The cranks in each vertical set have their positions always alike. The number of cranks, whether taken horizontally or vertically, is arbitrary—a matter of convenience in construction. The synchronous revolution of the cranks is effected by means of any suitable mechanism; such as, equal toothed wheels on the several axes, with alternate idle wheels connecting them; or, equal rag-wheels, with endless chain, or metallic ribon; or, equal cranks, with a rigid connecting frame, or plate. The first method is used in the original machine, the third in the model for the Patent Office, the second and third in the larger and smaller sizes, respectively, for the market.

The crank pins represent as many liquid particles; the circles on the background their orbits. The transverse wires represent continuous lines of particles, which at rest would be horizontal, and be represented by the lines on the background drawn just below the centers of the orbits; the upper one of these being the surface line, the lower a line of particles one ninth of a wave's length down. The upright wires represent lines of particles which at rest would be vertical. Every point in these moving lines describes its own distinct orbit.

The apparatus is constructed to a scale; and so, represents a wave of given length, height, and period; but equally represents, also, a wave of any other length and proportionate height, though of period proper to its length, according to the law of that relation, as stated farther on. In the original instrument, for example, the wave length is 36 inches; height, from trough to crest, 4 inches; and period, for that length, $0^{s}\cdot76$; but it equally represents a wave whose length is 36 feet and height 4 feet, with period $2^{s}\cdot63$; and similarly, for other proportional dimensions.

Among the particular points, in wave phenomena, which are elucidated by this apparatus, may be enumerated the following:

1. *The undulating surface-profile.* This is shown in the motion of the upper flexible wire, which presents a continuous contour line, of the exact curvature, throughout, of a true normal wave; instead of a broken contour, of arbitrary form, by means of rising and falling balls, as in the ordinary wave apparatus.

2. *The undulatory motion of all sub-profiles, or lines of equal pressure, down to still water.* The representative of such lines is the lower transverse wire, which moves similarly to the upper one, but with a less curvature. Every such line of equal pressure is a continuous one, composed of particles in a state of dynamical equilibrium, and constituting an ideal moving wave, exactly as if at the surface—the corresponding phases of all such waves being on vertical lines.

3. *The genesis of the undulatory motion from the circular motion of revolution.* This is seen in the mode in which the crank-pins, in each transverse series, or the particles which they represent, come in regular succession into a given position, as they revolve synchronously in their orbits.

4. *The equality of the height of a wave, from trough to crest, with the diameter of the orbits of the surface particles.* This is obvious in the apparatus, and follows directly from the mode in which the wave surface is generated.

5. *The direction of motion of particles of water in the different phases of a wave.* A glance at the motion of the crank pins, shows that a particle at the wave's crest is moving forward, or in the direction in which the wave is propagated, and a particle at the trough in the reverse direction, or backward; that a particle on the forward slope is rising, and one on the back slope descending. The same is true of particles in all the sub-waves, or surfaces of equal pressure, down to still water.

6. *The length of a pendulum keeping time with the wave.* This is equal to the radius of a circle whose circumference is the wave's length. Such a circle is the large one drawn on the background, as shown in the figure. Its radius is to that of a particle's orbit (or length of a crank arm), as the particle's weight is to its centrifugal force. Or, putting R and r for these radii respectively, and t for the time of revolution, we make

$$R : r :: g : \frac{4\pi^2 r}{t^2};$$

Whence

$$t=2\pi\sqrt{\frac{R}{g}};$$

which is the period of a revolving pendulum, or the time of a double oscillation of a simple pendulum, whose height is R. Compare (10).

7. *The dependence of a wave's period on its length alone—not on its height.* This is a corollary from the preceding. The period varies as the square root of the length, and is the same for all sub-waves, as for the surface wave—the length being the same for all. The height, within certain limits, is independent of the length, as appears in the apparatus, and as may be inferred from the formulæ given farther on. It depends on the centrifugal force of the particle, and this, ultimately, on the external forces generating it.

8. *The varying direction and intensity of the resultant force acting, at each instant, on a given particle in a wave.* The component forces are two—the particle's gravity, and its centrifugal force. The former is represented by the vertical radius of the large circle, the latter by the radius vector of the revolv-

ing particle; their resultant, then, is represented by the third side of the triangle of forces, or the side formed by the wire pendulum. This resultant must be always normal to the wave surface, as the wire pendulum is seen to be always at right angles to the elastic wire representing that surface.

9. *The condition of a wave's rupture at the crest.* When the centrifugal force becomes equal to gravity (or the radius of the orbit to that of the large circle), the resultant force, for a particle at the highest point of its orbit, or crest of the wave, must be zero, and the particle consequently fly from its orbit, or the crest break in foam.

10. *The trochoidal form of the wave curve.* The point of suspension of the pendulum, that is, the upper extremity of the vertical radius of the large circle, may be regarded as the instantaneous center about which an element of the wave curve at the point of normalcy of the pendulum is described. Consequently, if this circle be rolled under a horizontal straight line, a point within it distant half the height of a wave from the center, will trace the wave profile; which therefore is a trochoid. The rolling circle is the same for all wave profiles, down to still water, the lengths of the tracing arm only differing. The circumference of this circle equals, of course, the wave's length.

11. *The greater sharpness of the crests than of the troughs of waves.* This follows from the preceding, and is shown in the relative positions of the crank-pins—nearer together at the crests, farther apart in the troughs. The trochoids become, necessarily, sharper at the upper bend, and less so at the lower, as the tracing-arm approaches to an equality with the radius of the rolling circle; until, when that equality occurs, the trochoid passes into the cycloid, which has sharp cusps. The cusp of the inverted cycloid, then, is the limit of sharpness of a wave's crest. The equality above named is equivalent to that of the centrifugal force of a particle with its gravity (9). When the latter condition occurs, the wave curve is cycloidal, and only then.

12. *The limits of possible curvature of waves.* That curvature must always lie between the cycloid at the one extreme, and the straight line at the other—embracing trochoids of every possible variety.

13. *The greater elevation of the crests above the level of still water, than depression of the troughs below it.* The difference between this elevation and depression is equal to twice the height due to the orbital velocity of the particles, that is, to twice the height from which a body must fall to acquire that velocity; or, is a third proportional to the radius of the rolling

circle and that of the particle's orbit; that is, putting R and r for these radii respectively, v for the orbital velocity, $\left(=\frac{2\pi r}{t}\right)$, and D for the difference in question,

$$D=\frac{r^2}{R}=\frac{v^2}{g}.$$

When r equals R, then $D=r$, or half the height of the wave.

14. *The elevation of the centers of the orbits of particles above the positions of the same particles at rest.* This is shown in the distance of the axes above the corresponding lines on the background. These lines show the positions of lines of particles at rest, which, in motion, form the wave profiles represented by the transverse wires. The elevation in question is equal to the height due to the particle's orbital velocity; or, is a third proportional to the diameter of the rolling circle and the radius of the orbit; or, is equal to the area of the orbit divided by the length of the wave; that is, putting H for this elevation, l for the wave's length, and the other symbols as before,

$$H=\frac{r^2}{2R}=\frac{v^2}{2g}=\frac{\pi r^2}{l}.$$

When r equals R, $H=\frac{r}{2}$, or one-fourth the height of the wave. To this elevation is due one half the mechanical energy of a wave—the other half to the motion of its particles. That energy is, in other words, half potential, half actual.

15. *The decreasing diameter of the orbits with depth.* This is seen in the shorter crank-arms below, and the decreasing amplitude of sway of the upright elastic wires, down to their points of rest, which mark the depth of still water. The decrease of the orbits in diameter takes place in a geometrical ratio, and is approximately one half for each increase of depth equal to one ninth of a wave length; or, more exactly, putting r and r' for the radii, respectively, of a surface orbit and of one whose middle depth is k, it is $r'=re^{-\frac{k}{R}}$, R being, as before, the radius of the rolling circle, and e the base of the Naperian logarithms.

16. *The peculiar swaying motion of continuous lines of particles of equal pressure, which at rest are vertical.* These lines are alternately lengthened and shortened, and bent to right and left, as represented by the upright elastic wires.

17. *The varying distortions undergone by blocks or sections of water originally rectangular, or rectangular when at rest.* Such sections are represented by the spaces between the wires, and their distortions by the distortions of these spaces.

18. *The fact of sensibly still water at half a wave's length below the surface.* This is exhibited in the absence of lateral motion at the lower extremities of the upright wires, and is a necessary result of the law of diminution of orbits with depth, as given above (13).

19. *The varying strain, in wave action, on floating bodies.* This is seen in the varying angle made by the upright wires with the upper transverse wire; the latter shows the position of a raft, for example, lying on the wave surface; the former, that of a long, thin body, as a board, floating end down; hence, the varying relative direction of the wires shows the strain to which a body is subjected, having both breadth and depth, as the hull of a vessel.

Many other points, besides the above, may be studied to advantage in connection with this apparatus, but it is not important to specify them here. Enough have been stated to illustrate its utility, and indicate in what respects it differs from every other form of wave apparatus.

For convenience of reference, and for the sake of completeness, a few formulæ are added, expressing other relations among wave phenomena, not so directly exhibited by the instrument, but important to be presented in connection with it. Putting V for the velocity of propagation of a wave, and the other symbols as before, the length of the wave is

$$l = 2\pi R = \frac{gt^2}{2\pi} = \frac{2\pi V^2}{g} = tV;$$

its period $$t = \sqrt{\frac{2\pi l}{g}} = 2\pi\sqrt{\frac{R}{g}} = \frac{l}{V};$$

the velocity of a particle in its orbit, or at the crest of the wave,

$$v = \frac{2\pi r}{t} = r\sqrt{\frac{g}{R}} = r\sqrt{\frac{2\pi g}{l}} = \frac{Vr}{R} = \frac{2\pi r V}{l} = \frac{gr}{V} = \frac{tgr}{l};$$

the velocity of propagation of the wave

$$V = \frac{l}{t} = \frac{gt}{2\pi} = \sqrt{\frac{gl}{2\pi}} = \sqrt{gR} = \frac{gr}{v};$$

the sine of the angle of steepest slope of surface is

$$\sin\theta = \frac{2\pi r}{l} = \frac{r}{R}.$$

It will be understood that the normal wave, to which the theory applies, and which the apparatus illustrates, is the wave on deep water, or water a wave's length, at least, in depth. In shallow water, the orbits are no longer circles, but ovals, or approximate ellipses, of less height than length, according to the degree of shallowness.

When waves pass from deep into shallow water, as toward a beach, they become gradually shorter, their total energy is imparted to a less and less mass of liquid, and the extent of the motion of the particles is proportionately increased. The crests also travel faster than the troughs; so that the front of each wave becomes by degrees steeper than the back, and at length curls forward and falls over, exhibiting the well known roll of surf. The formulæ for waves in deep water require modification, therefore, to adapt them to waves in shallow water, where depth of liquid and ellipticity of orbit enter as elements.

It has been necessary, in order properly to explain the apparatus and its uses, to give more fully the leading points of the theory of waves, than would be required, were the works containing it more generally accessible. For these points the papers of Prof. Rankine have been chiefly consulted. It is hoped that this outline of the theory, thus incidentally given, will prove not unacceptable to such instructors as may not have at hand the original works; and that this new piece of apparatus may contribute somewhat toward imparting a clearer understanding of the phenomena of waves.

The apparatus has been patented, and is manufactured by Messrs. E. S. Ritchie & Son, the well known philosophical instrument makers, of Boston, Mass. L.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On the effects of coloration presented by discharges from an inductorium taking place between a platinum wire and the upper surface of a liquid.*—E. BECQUEREL has communicated to the Academy of Sciences in Paris the details of an investigation some of the results of which appear to be of particular interest and value. The apparatus employed was very simple, and consisted merely of a glass tube partly filled with a saline solution in contact with a platinum wire forming one pole of an inductorium. The other pole consisted of a platinum wire the extremity of which was placed a few millimeters above the surface of the liquid, the discharge taking place between this last and the wire. When the inductorium is of low power no coloration is observed when the liquid is positive and the wire negative, but only when the wire is positive. But when the coil is powerful and the salt dissolved easily vaporized, coloration is observed in either case, though the maximum is given when the wire is positive. With a sufficiently powerful coil the luminous effects of the discharge are very bril-

liant. The spectrum of the light produced in this manner is more complex than that resulting from the introduction of small quantities of saline matter into a non-luminous flame. The water is vaporized and we have lines due to oxygen and hydrogen; the temperature is also higher than that of the flame of a Bunsen's burner. With very pure water the intensity of the discharge is feeble and the spectrum contains the red and blue hydrogen line corresponding to the dark rays C and F of the solar spectrum. With a strong solution of chlorhydric acid in water the tint of the discharge is slightly violet and the two red and blue rays are more distinct than with water. There are also an orange band and a few fainter rays throughout the extent of the spectrum. A very small quantity of a saline substance in water is sufficient to communicate to the light of the discharge the color due to the elements of the salt. Thus water containing one one-thousandth part of its weight of chlorid of strontium gives very distinctly the orange and blue rays characteristic of strontium. With concentrated solutions the effects are more marked and with the chlorids in particular they are very brilliant. Thus the chlorids of strontium, calcium, sodium, magnesium, copper and zinc give fine effects. But other substances such as various compounds of barium, potassium, antimony, iron, manganese, silver, uranium, &c., give effects which are more or less marked. In general the lines are more numerous than in the spectra of flames containing the same saline elements, which doubtless arises from the higher temperature, but in all cases the lines are the same as those given by Bunsen and Kirchhoff. Thus with a saturated solution of chlorid of strontium, besides the orange and the clear blue, we see two violet rays, one more intense than the other, several green rays one of which is particularly distinct, and a certain number of feebler rays in different parts of the spectrum. Chlorid of lithium, besides the red and the feeble orange, gives a very vivid blue ray. A concentrated solution of chlorid of calcium gives a great number of rays among which the dark blue ray is very intense. Chlorid of magnesium, besides other lines, gives two very bright green and one clear blue ray. Chlorid of zinc gives a red ray, three brilliant blue rays and a very intense violet line. Nitrate of silver gives among other rays, two of a vivid green. In conclusion the author points out the very obvious and marked advantages which this method of observation offers in certain cases over the usual method of ignition in a non-luminous flame.—*Comptes Rendus*, lxvi, 121.

W. G.

2. *On the permeability of cast iron to the gases produced in combustion.*—At the instance of Gen. Morin, Messrs. H. Sainte-Claire Deville and Troost have made precise analyses of the air which circulates round a stove of cast iron strongly heated. The authors have found that this air contains hydrogen and oxyd of carbon in notable quantities. This fact is perfectly explained by the permeability of iron at high temperatures to gases and by the property which iron possesses of condensing oxyd of carbon, dis-

vered by Graham. As the gases traverse the iron even at a dull d heat the authors call attention to the poisonous effect which e oxyd of carbon must produce and attribute to its presence the ıpleasant sensations which are always experienced in rooms ated by cast iron stoves or by air heated by contact with hot on plates.—*Comptes Rendus*, lxvi, 83. W. G.

3. *On stellar spectra.*—SECCHI has communicated to the Acadny of Sciences in Paris some further observations on stellar speca, made by means of a new spectroscope with a cylindrical hromatic eye-piece. The author's conclusions are as follows: t. Red stars have generally spectra of the third type (like α rion, α Hercules, β Pegasi, Antares, o Balænæ, &c.); when the lor is pale it may be referred to an intermediate place between e second and third. 2d. A great number of these stars of the th or sixth magnitude have their spectra perfectly resolvable o columns which are afterward themselves resolvable into finer ıes; such are the following:

Right ascensions.	Declinations.	Magnitudes.
$5^h\ 24^m\ {\cdot}1^s$	$+\ 18°\ 29'$	5·5
$4^h\ 46^m\ {\cdot}5^s$	$+\ 2°\ 16'$	5·5
$4^h\ 44^m\ 37^s$	$+\ 14°\ 1'$	5
$22^h\ 59^m\ 57^s$	$+\ 8°\ 39'$	5·5
$23^h\ 11^m\ 6^s$	$+\ 48°\ 15'$	

ıere are many others which cannot be resolved into secondary ıes on account of the faintness, but of which the principal lines suf:e to indicate the type. 3d. The stars which cannot be referred the three established types are very rare. The author has exnined several hundred stars below the seventh magnitude, one hich is very extraordinary is found in Lalande's Catalogue, ($\alpha =$ $54^m\ 10^s$, $\delta = +\ 0°\ 59'$). In the spectrum of this star the red divided into two bands by a broad obscure line, the yellow is duced to a very clear and bright line, then comes a broad dark ınd, then a broad greenish-yellow band, then another dark space ıd then a blue zone. (The author gives a curve representing this ıectrum. We may here remark that it is exactly analogous in ɜneral character to the spectra produced by colored liquids.— . G.)—Sirius seen with the new spectroscope exhibits with great stinctness the beautiful dark band in the extreme red. Between ıis and the sodium line D there is a very delicate nebulous ray. he author hopes soon to furnish exact measurements of the rays, ter finishing a general survey of the heavens with a view of decting the most remarkable stars.—*Comptes Rendus*, lxvi, 124.

W. G.

4. *On the reduction of niobium and tantalum.*—MARIGNAC has ade various attempts to obtain niobium and tantalum in the etallic state. These efforts though unsuccessful as regards their ımediate object have resulted in the discovery of several new ıd interesting compounds. Fluoniobate of potassium is reduced ithout difficulty by sodium in a crucible of wrought iron, but the

product of the action is an alloy of sodium and niobium or niobid of sodium which presents itself under the form of a black powder. Water decomposes this body and transforms it into a niobid of hydrogen containing about 1 per cent of hydrogen and having the formula, NbH. The substance obtained by Rose was certainly a protoxyd of niobium, Nb_2O. The niobid of hydrogen is an extremely fine black powder of density 6—6·6. It is not attacked by chlorhydric, nitric or dilute sulphuric acid, but may be attacked and dissolved by concentrated boiling sulphuric acid and by fused alkaline bisulphates by boiling with caustic alkalies and particularly by fluohydric acid even when dilute. When heated in the air it ignites and is converted into niobic acid. The niobid of hydrogen is very stable and may be ignited for an hour in a current of hydrogen without change, except that its density increases to 7·37. Fluoniobate of potassium heated with magnesium produced a violent explosion. The reduction with aluminum in a crucible of graphite, yields a niobid of aluminum, $NbAl_3$, which is a highly crystalline iron grey powder, with a strong metallic luster and with a density of 4·45 to 4·52. Fluotantalate of potassium yields with aluminum an alloy of similar constitution and properties. The density of this body is 7·02; it dissolves easily in fluohydric acid.

H. Sainte-Claire Deville in presenting the above mentioned paper of Marignac described two new compounds of niobium obtained by himself but not analyzed. When niobate of potash is heated to about 1200 degrees with a small excess of carbonate of potash in a crucible of graphite surrounded by a mixture of rutile and carbon, very beautiful black cubes are obtained which are converted by chlorine into a mixture of chlorid and oxychlorid of niobium. When the calcination takes place in a crucible of graphite heated to the highest possible temperature, but not surrounded by rutile and carbon, prismatic crystals are obtained of a magnificent dark bronze color which are doubtless the nitro-carbid of niobium analogous to the well known titanium compound analyzed by Wöhler.—*Comptes Rendus*, lxvi, 180 and 183. W. G.

5. *Researches on Vanadium.*—The study of the compounds of vanadium by Berzelius led to the conclusion, since universally accepted by chemists, that vanadic acid like chromic acid has the formula, VO_3, and that the equivalent of the metal, using the term equivalent in its older and less logical sense, is 68·5. Roscoe has presented to the Royal Society an elaborate memoir, in which setting out from the well known isomorphism of vanadinite with apatite, pyromorphite and minetisite, he shows conclusively that vanadium belongs to the nitrogen group of elements and is triatomic and pentatomic. The grounds upon which these conclusions are based are in the author's words as follows:

1. An oxyd of vanadium exists having the atomic weight 67·2 (that of the metal of Berzelius). Hence vanadic acid contains more than three atoms of oxygen.

2. The following vanadium oxyds have been obtained both in the dry and wet way and their composition determined:—

(1.) VO vanadium monoxyd, or vanadyl, = 67·2
(2.) V_2O_3, vanadium sesquioxyd, (Berzelius suboxyd) " 150·4
(3.) VO_2, vanadium dioxyd, " 83·2
(4.) V_2O_5, vanadium pentoxyd (vanadic acid), " 182·4

3. The so called terchlorid of vanadium, VCl_3, (V=67·2), contains oxygen; it is an oxychlorid having the formula $VOCl_3$ (V=51·2); it may be called vanadyl trichlorid, or vanadium oxytrichlorid, and corresponds to $POCl_3$, phosphoroxyl trichlorid.

4. Three other solid oxychlorids exist, having the composition

1st. $VOCl_2$, vanadyl dichlorid, or vanadium oxydichlorid.

2d. VOCl, vanadyl monochlorid, or vanadium oxy-monochlorid.

3d. V_2O_2Cl, divanadyl monochlorid.

4th. All the native vanadates are tribasic.

5. Vanadium pentoxyd fused with sodium carbonate displaces three molecules of carbonic dioxyd, showing that normal or ortho-sodium vanadate is tribasic, the formula of this salt being Na_3VO_4.

6. The so-called mono-vanadates are salts corresponding to the mono-basic phosphates, and may be termed meta-vanadates, thus, $NaVO_3$, NH_4VO_3, $Ba2VO_3$. The so-called bivanadates are anhydro-salts, similar in constitution to the anhydro-salts of chromic and boric acids.

7. Vanadium nitrid has been prepared, which, on analysis, was shown to contain 51·2 parts by weight of vanadium to 14 parts of nitrogen.

The author determined the atomic weight of vanadium by the reduction of vanadic pentoxyd in hydrogen—the method originally employed by Berzelius. The mean of four determinations gave the number 51·37 with a mean error of ±0·066. Berzelius's number calculated in the same way for V_2O_5 is 52·55.

Monoxyd of vanadium, VO=67·2, is a gray powder having a metallic luster and is obtained by passing the vapor of vanadyl trichlorid, $VOCl_3$, mixed with excess of hydrogen through a combustion tube containing red-hot carbon. The oxyd in solution may be obtained by the action of nascent hydrogen upon a solution of vanadic in sulphuric acid. The solution has a lavender tint and is a very powerful reducing agent. It quickly absorbs oxygen from the air and becomes chocolate-brown.

Vanadic sesquioxyd, V_2O_3=150·4, (Berzelius suboxyd) is obtained as a black powder by reducing vanadic pentoxyd in hydrogen at a red heat. When exposed warm to the air it glows and passes to the highest oxyd. At the ordinary atmospheric temperature it slowly absorbs oxygen and gives the dioxyd. It is insoluble in acids but may be obtained in solution as a green liquid by the action of metallic magnesium upon a solution of vanadic in sulphuric acid.

Vanadic dioxyd, VO_2=83·2 (the vanadic oxyd of Berzelius) may be prepared in the form of blue shining crystals by allowing *the sesquioxyd to absorb* oxygen at ordinary temperatures. Solutions of this oxyd having a bright blue color may be obtained by the action of moderate reducing agents upon vanadic acid in solution.

Vanadyl trichlorid, $VOCl_3$=173·2, was proved to contain oxygen by obtaining CO from the decomposition of the vapor by red hot charcoal; by the production of magnesia by the action of magnesium; by the formation of caustic soda by the action of sodium; by the formation of vanadic sesquioxyd by passing the vapor of the oxychlorid with pure hydrogen through a hot tube. Its density was found to be 1·841 at 14°·5 C., its vapor density 88·2 (H=1), and its boiling point 126·7 C. under a pressure of 767·0^{mm}. Nine analyses of this body gave 51·05 as the atomic weight of vanadium, the mean of which and the number already given 51·37 is 51·21 which the author adopts as the true atomic weight.

Vanadyl dichlorid, $VOCl_2$=137·9, is a light green crystalline body obtained by the action of zinc on the trichlorid at 400° in sealed tubes. Its density is 2·88, it is insoluble in water but deliquesces on long exposure to air and dissolves easily in acids.

Vanadyl monochlorid, $VOCl$=102·57, is a brown light powdery solid formed by the action of hydrogen upon vanadyl trichlorid at a red heat. It is insoluble in water but readily soluble in acids. Divanadyl monochlorid, V_2O_2Cl=169·8, is also formed by the action of hydrogen at a red heat upon $VOCl_3$. It is a heavy shining metallic powder resembling mosaic gold in appearance. Vanadium mononitrid, VN, is a greyish powder unalterable in the air, obtained by heating the ammonium oxychlorid to whiteness in a current of ammonia. The dinitrid, VN_2, is the black powder obtained by Uhrlaub by heating the ammonium oxychlorid. The author promises to describe the compounds of vanadium with the halogens in another communication.—*Proceedings of the Royal Society*, xvi, 220. W. G.

6. *On the compounds of niobium and tantalum with chlorine and oxygen.*—H. SAINTE-CLAIRE DEVILLE and L. TROOST have communicated a few notes on niobium and tantalum which are of value as fully confirming the views of Marignac upon the atomic constitution of the compounds of these metals. Niobic acid was heated to redness in a platinum boat in a glass tube through which a current of dry carbonic acid was passed; chlorid of niobium $NbCl_5$ (fusing at 194° and boiling at 240°) was then repeatedly volatilized over the acid. The niobic acid disappeared almost completely to form a white silky body volatilizing at 400° which possessed all the properties of oxychlorid of niobium:

$$Nb_2O_5+3NbCl_5=5NbOCl_3.$$

No oxychlorid of tantalum could be obtained by the same process. Chlorid of tantalum—prepared from tantalic acid purified by Marignac's method—is a solid crystallizable body which melts at 211°·3 and boils at 241°·6 under a pressure of 753^{mm}. It has a pale yellow color and rapidly changes in the air, giving off scarcely visible vapors of chlorhydric acid and becoming covered with tantalic acid. Its vapor density at 360° was found to be 12·8 and at 440° 13·0; for a condensation to 4 vols. the formula $TaCl_5$ (Ta=182) should give 12·5. The density of tantalic acid precipitated from the chlorid by ammonia and ignited to low redness was 7·35.—*Comptes Rendus*, lxiv, 294. W. G.

II. MINERALOGY AND GEOLOGY.

1. *On the Age of the Gold-bearing Rocks, of California;* by Wm. H. Brewer.—In the last number of this Journal (this volume, p. 266), in a note on the Carboniferous Age of the gold-bearing rocks of California, by Prof. W. P. Blake, he complains of a single sentence in a previous article of mine (this Jour., July, 1866, p. 116), beginning with "and in the later pages of the same work he paves the way for priority of discovery," &c.

I beg here to say that I regret using the personal imputation in that sentence, and willingly retract it. It should not have been written, however great the provocation, and I especially regret using it as it had little or nothing to do with the argument of that article, and is now used to call attention away from the question there discussed to the alleged personal grievance.

That article by me was written in defense of the Geological Survey against certain imputations against it and certain of its members, put forth by him in a certain pamphlet containing claims for discoveries, and certain unwarranted statements. In his recent article he does not attempt to meet the facts I have published relating to the actual discoveries by the Survey, but speaking of the paragraph already referred to, says, "he controverts the written statements * * * by partially citing paragraphs from my Report," &c.

I certainly have no desire to misrepresent him nor his position. Inasmuch as he commits the same wrong he accuses me of, by but "partially citing paragraphs" from the same report, omitting some decidedly suggestive sentences, I would therefore respectfully suggest that any person curious in this matter should read the *whole* of those portions of his report which bear upon this question, and then form his own opinion as to what they really mean and what they are worth. (Geological Reconnoissance in California, preface iv, p. 276, 278 and 279.) It will be more suggestive if these be read entire and in connection with his later pamphlet and his recent article, where portions are cited, other portions omitted and the whole curiously explained.

In this recent article, Prof. Blake remarks that in my articles which he criticises, I made statements to the effect "that it was reserved for the Geological Survey to show that the gold-bearing rocks were not of these older periods. This is an error, inasmuch," &c. (p. 265). I did state that the State Geological Survey was the first "*to show*" this very thing, and I brought forward proofs of the correctness of the statement. I do not see the *error* he accuses me of, inasmuch as he does not meet a single item of *these proofs, but* instead offers some of his old surmises.

When I wrote those articles I was not ignorant that *surmises* had been recorded before, that "possibly" the rocks in question might be in part Carboniferous, but the articles in question dealt rather with what the Geological Survey had proved than with what others had guessed at.

I freely admit that surmises had been copiously put forth in Prof. Blake's report, and upon a variety of questions. He surmises that the Sierra limestones are "*possibly*" Carboniferous, (the Geological Survey has since *proved* the fact)—and also surmises that the gold rocks will in a great part "ultimately be found to be Devonian,"—that they may be "Silurian,"—that they were "probably impregnated with it [gold] after the Miocene period," —that the coast Ranges had been covered with the sea until "Post Tertiary times,"—and so on through a suggestive list of surmises, a few of which have been justified by later investigation, the most of which however are now known to be unfounded.

A paragraph in this recent article appears to indicate that he as much underrates the value of facts as he overrates the value of possibilities. Respecting the *age* of the very rocks in question, (the surmise of which age "was a bold step in advance,") he says (p. 266) "that as regards the portion of the gold-belt under consideration it is as yet a matter of opinion, not of demonstration." If he means by this that *he* never demonstrated it nor ever discovered one fact which could demonstrate it, or indeed throw any light at all upon it, then it is doubtless true; but if he means that it has not been demonstrated at all, as the language implies, then it is untrue. Apparently to illustrate that the last is his meaning, and to make it look probable, he adds, "The discovery of other localities of Carboniferous fossils in the northern part of the state, at Bass Rancho and Genesee Valley has afforded additional evidence, and yet Mr. Brewer very justly does not positively assert the Carboniferous age of this belt southward," &c. Here again Prof. Blake values facts too lightly as compared with the surmises which precede the quotation, and in but "partially citing paragraphs from *my* report," he curiously omits to mention that I had cited another locality of Carboniferous fossils many miles farther "southward" where the fossils are found in at least two beds or localities, separated by auriferous slates, and both enclosed in those slates. The locality is mentioned in the paragraph which he "partially cites."

It would be profitless to call attention to some other peculiarities of this recent article. I have published some of the more important facts and data relating to actual discoveries bearing upon the question. I did not exhaust the list, it could have been greatly extended, but it was considered sufficient for the purposes of the articles in which the statements appeared. It never occurred to me then that any one would attempt to throw discredit upon the facts themselves, without attempting to meet one of them, or to question the conclusions which they indicated, without bringing forward counter facts indicating other conclusions. Unless facts and proofs are fairly brought forward to meet the statements I have recorded, I must decline further discussion upon this question.

But if scientific demonstration is to be placed upon the same footing as to value with mere suggestions and vague surmises, then I have nothing more to say. In that case, the sooner Geological investigation changes its mode of operations the better, and then let laborious exploration in the field give way to the richer results of a fertile imagination in the house.

New Haven, April, 1868.

2. *On Coal in Nebraska, with reference to a paragraph in the Geological Report of Dr. Hayden;* by C. A. WHITE, M.D. (Communicated for this Journal).—In the report of progress of the Geological Survey of Nebraska by Dr. F. V. Hayden, published in the valuable report of the Commissioner of the General Land Office for 1866, just issued, I see Dr. H. has, from some misunderstanding, alluded to a conversation between Mr. Meek and myself in his presence, at Nebraska City, respecting the probabilities of finding workable beds of coal there by deep mining. As the statement stands in his report, I am afraid that without further explanation some of the citizens of Western Iowa, who are interested in the subject of coal there, may be misled in regard to my real views upon that subject.

On page 125 of that report Dr. H., after mentioning the fact that Mr. Meek and myself had examined the country across from the Des Moines valley to Nebraska City, says that "the conclusion they arrived at was, that the workable beds of coal occur in the lower Coal-measures, and that those beds would be found by boring from 300 to 500 feet below the water level of the Missouri at Nebraska City."

In May, 1867, I invited Mr. Meek, as an old and highly valued scientific friend, to join my camp and cross the State of Iowa with me to Nebraska City, when on his way to Nebraska. I had, the year before, traced the Coal-measure rocks from the Des Moines to the Missouri river, and published the results, announcing the fact that nearly all the workable beds of coal in Iowa were to be found in the lower Coal-measures, and my object was to review the same in company with Mr. Meek. Upon our arrival in Nebraska we summed up the sections of the Coal-measure rocks we had made in Iowa, and found them to amount to between three and four hundred feet. In the conversation alluded to, which was held at the house of a mutual friend, we stated that *unless the upper unproductive member of the series should prove to be much thicker at and near Nebraska City than in Central Iowa* (no sections of the whole series were seen by us in Western Iowa), we thought it probable that the equivalents of the lower Coal-measures would be reached within 500 feet of the bottom of the Missouri valley. Neither of us, I am sure, had the slightest idea that what we stated to our friend would be understood by any one as a "*conclusion*" that beds of coal "*would be reached*" at any designated depth. The problem is far too difficult a one to be disposed of in so summary a manner, especially as we had at that time scarcely more than commenced examinations in Nebraska. A few days after, we learned that borings had already been made at Omaha and Nebraska City to the depth of four hundred feet without finding a workable bed of coal. From these facts, and our examinations made immediately afterward along the Missouri river between Omaha and Nebraska City, we both arrived at the conclusion that the upper, unproductive series thickens more rapidly in extending westward from Central Iowa than is indicated by any evidence to be seen in traversing that State, and that it would be unsafe, in our present state of knowledge, to attempt to decide in regard to the actual depth at which the equivalents of the lower Coal-measure strata would be reached there, and that actual boring alone could decide whether *coal* existed there or not.

This conclusion was discussed by us in camp at the close of our examinations, in the presence of the whole party, Dr. H. included, and I supposed was understood by all.

My views in regard to the Coal-measures of Iowa, so far as they are yet formed, may be learned by consulting my articles in this Journal, and my reports. See First and Second Annual Reports of Progress, &c., of the State Geologist, Des Moines, March, 1868.

3. *Note on the shell-structure of certain Naiades;* by C. A. White, M.D. (Communicated for this Journal.)—Those who have given attention to fossil lamellibranchiates cannot fail to have observed that whenever the shell-substance is preserved at all, it is universally thin, even in large specimens; too thin indeed to have given sufficient protection to the mollusc which it enclosed. It seems evident therefore that some portion of the shell-substance must have disappeared during the process of fossilization. Thus those fossil shells which possess a prismatic outer layer usually have this layer alone preserved, at least when they occur in calcareous strata. Numerous specimens of *Myalina subquadrata* from the Upper Coal-measures, and *Inoceramus problematicus* of the Cretaceous of Western Iowa illustrate this well, in which the interior markings are uniformly obliterated. While lately examining the Naiades of the Iowa river I observed that they all possessed a prismatic outer layer of a character not distinguishable from that of *Myalina subquadrata.* The prisms are of about the same size in each, but those of the Inoceramus are nearly twice as large.

The following species have thus far been found to possess the characters referred to: *Unio alatus* Say, *U. cornutus* Barnes, *U. crassus* Say, *U. ebenus* Lea, *U. plicatus* Say, *U. rectus* Lam., *U. securis* Lea, *U. tuberculatus*, *U. ventricosus* Barnes, *Alasmodonta complanata* Barnes, *A. truncata* Say, and an undetermined species of *Anodonta.*

This comprises all the genera (or sub-genera) found in our region, but it is not improbable that the prismatic structure is common to the whole family. The prismatic layer is of about the same thickness in all, the Anodontas and Alasmodontas being thinned at the expense of the inner, or structureless layers. It is from half a millimeter to more than a millimeter in thickness, the epidermis resting directly upon it. Except in very old specimens, this layer constitutes the whole thickness of the shell for the width of a couple of millimeters from the margin, and in very young specimens it exclusively occupies about half the space between the margin and the pallial line.

The prismatic structure may be detected by the naked eye and can be well studied by the use of one of Tolles's ¾ inch triplet lenses. Under this magnifier the inner surface of the marginal border is seen to be finely granular, each granule being the convex end of one of the prisms which constitute the layer. These prisms extend through the layer to the epidermis without interruption, reminding one in their appearance upon fracture, of certain species of *Chætetes*. But viewing the prisms upon their ends they are seen to vary in size much more than the cells of *Chætetes* do, and consequently to lack that uniformity in cross section, presented by the coral.

If our Naiades were fossilized under the same circumstances that the Coal-measure and Cretaceous shells before mentioned have been, even the most massive Unios would doubtless be found with as thin a shell as *Myalina* and *Inoceramus* now possess.

Mr. F. B. Meek's investigations have shown that the prismatic structure is a very common, if not a constant character of the fossil Aviculidæ, and it is doubtless of much value as a family character; but since it is also seen in certain genera of Mytilidæ and the Naiades, it is known that it is not the peculiar property of any family.

4. *Note on "Cone in cone;"* by C. A. White, M.D. (Communicated for this Journal.)—The structure known as "cone in cone" or "tutenmergel" is quite common in the calcareo-carbonaceous shales of the Lower Coal-measures of Iowa. It usually occurs in somewhat concretionary layers, from four to twelve inches thick, the apices of the cones pointing downward. Being much interested in the views advanced by Prof. O. C. Marsh in relation to the origin of this structure, I was somewhat surprised to discover last summer in Southern Iowa, some facts which seem to be at variance with the opinion that the peculiar structure in question was produced by pressure upon the concretionary mass while it was forming. A couple of examples were found there which presented the cone-like structure radiating from a center, the apices of the cones all pointing to that center. The concretions were imbedded in the common dark shales of the Coal-measures, the largest one being about two and a half feet in transverse diameter, and one and a half feet in vertical thickness. It was broken open so that a vertical section was presented in its natural position in the face of the bank. The structure was plainly seen radiating as before described, being as distinct at the ends of the mass as in the upper and under

portions, and of the same character throughout. Thus in the same mass the apices of the cones were pointing in all directions.

Iowa City, Iowa, March 27th, 1868.

5. *First and second Annual Reports of progress by the State Geologist, and the Assistant and Chemist, of the Geological survey of the State of Iowa*, together with the substance of popular letters contributed to the newspapers of the State during the years 1866 and 1867, in accordance with law; also extracts originally contributed to scientific journals as a part of the work of the survey. pp. 288, 8vo. Des Moines, 1868.—This important volume consists largely of the articles communicated to the newspapers of the State as mentioned in the title. As such popular exhibitions of the results of the survey were required by the legislature, it was natural that they should be embodied in the annual reports intended for general circulation among the people. These articles and a brief report of the progress of the survey with which the volume opens, show that Prof. White is well fitted for the work in which he is engaged, and that the survey is bringing out results of great interest to science and the State. We are happy to announce that the Legislature has passed a bill appropriating $6,500 annually, for two years, for the prosecution of the survey. They have added a stipulation that the survey shall be finished in that time, which we hope may be modified, as it is quite too brief a period for completing the thorough examination of an area larger than all New England, Maine excluded. Mr. O. H. St. John will continue assistant for the coming year.

III. BOTANY AND ZOOLOGY.

1. *Shortia*, Torr. & Gray, *and Schizocodon*, Sieb. & Zucc., *identical.*—At the end of the separate herbarium of Michaux, in the museum of the *Jardin des Plantes*, Paris, is preserved a specimen, ticketed, "Hautes montagnes de Carolinie, an Pyrola spec.? an genus novum?" The scapes bear the dehiscent capsule, tipped with a style, and surrounded by the sepals; the corolla and stamens are absent. A sketch of the specimen, a leaf, and the summit of one of the scapes were obligingly presented to me by Prof. Decaisne. With more zeal than judgment, I drew up the characters from this unique and incomplete specimen, and in this Journal for January, 1842, in a note to the account of a botanical excursion to the mountains of North Carolina, I published the plant under the name of *Shortia galacifolia*, Torr. & Gray. Contrary to my hopes and expectations, the plant has not yet turned up in its native haunts. The late Dr. Short, who has since gone to his rest, deserved better commemoration at our hands than this empty name of a most obscure plant. Indeed, our botanists, applying the old law maxim, "*de non apparentibus et de non existentibus eadem est ratio*," are not unreasonably doubting if there ever was any such plant. Some lucky botanist will probably rediscover it in the region around the Black Mountains. What I have now to announce is, that the genus is found, and probably the very species, in a

widely distant region, indeed, but just where, after all we have been learning, it was not unnatural to expect it.

In the year 1843, if I mistake not (I cannot at this moment ascertain the exact date, none being given in the separate issue), the late Prof. Zuccarini published a plant from the mountains of Japan under the name of *Schizocodon soldanelloides;* and Dr. Maximowicz last year added two other species, *S. ilicifolius*, which he thinks too closely resembles the original species, and *S. uniflorus.* Of the latter, as well as of *S. soldanelloides*, Dr. Maximowicz has obligingly supplied me with specimens. *S. uniflorus* appears to differ (and perhaps too little) from the original species chiefly in the single-flowered scape, broader bracts, broader and more numerously-nerved sepals, and more slender style. Of this as of *Shortia galacifolia*, the corolla and stamens are unknown. Until these parts are found, and prove to be different, I may venture to assume that the two are identical!

Dr. Maximowicz, the latest and best botanical explorer of Japan and the adjacent regions northward, and whose excellent specimens have been liberally supplied to some of the principal herbaria of of this country (where they are most interesting), is sedulously engaged upon a *Flora Japonica.** It should be left for him to decide which generic name should be adopted, the earlier and incomplete or the later and complete one.

As to the affinities of the genus, I had thought mostly of *Galax*, itself of undetected relationship. The fringed, Soldanella-like corolla and the similar foliage are unaccompanied by any other structural resemblances. Zuccarini simply refers the genus to *Polemoniaceæ;* and I will add that its nearest known relative is *Diapensia.*

A. GRAY.

2. *Prolusio Floræ Japonicæ, scripsit* F. A. GUIL. MIQUEL.—We have recently noticed this interesting work as a part of the Annals of the Leyden Botanical Museum. It remains to add that, as a separate issue, it forms of itself a handsome folio volume, which is dedicated in complimentary and graceful terms to *Asa Gray* and to *C. I. Maximowicz.* It is indispensable to the study of Japanese Botany. We have just received also, from the same indefatigable author, a second essay,

Sur le Caractère et l'Origine de la Flore du Japon, an 8vo. pamphlet, and another upon the Japanese Maples. Neither time nor space will allow us at present to give an analysis of these works, and to enter upon the discussion of the most interesting problems brought before us by the comparison of the Japanese and North American floras, and of these with the Arctic tertiary flora recently illustrated by Heer, &c. In the preceding article we have added one more item to the curious chapter of facts, and we may return to the subject upon a future occasion. There are now very few peculiar Eastern North American types which are not directly represented (not rarely by identical species) in Japan or the adjacent regions, and the connection of all this with the former extension of North American types into Europe is now manifest enough. A. G.

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* *Apropos* to this, I would state that the Imperial Botanical Garden of St. Petersburg, to which Dr. Maximowicz is attached, is very desirous to obtain, for its herbarium, specimens of North American plants, and especially those of our western and southern districts;—for which Dr. M. and Dr. Regel, the Director of the Garden, offer liberal returns in specimens of plants of the wide Russian empire, &c.

3. *Genera Plantarum*; auct. G. Bentham et J. D. Hooker. Vol. i, 1862–1867.—We have already announced the completion of the first volume of this important work. It may be useful now to take note of its pages merely as they affect North American Botany.

Ranunculaceæ. The ambiguous *Thalictrum anemonoides* is referred back to *Anemone*, where Linnæus placed it. Its aspect suggests that view, but its carpological characters do not. Both genera would be better defined if this troublesome little plant could be generically separated, as has been once or twice attempted. *Cyrtorrhyncha* of Nuttall, though quite peculiar, is most properly referred to *Ranunculus*. So is *Aphanostemma* of South America,—which interests us on account of a new Californian species, with white Anemone-like sepals and minute glandular petals.

Dilleniaceæ. To this order Nuttall's *Crossosoma* is appended, as it technically ranges here rather than with *Pæonia.*

Calycanthaceæ, following a view propounded long ago by Dr. Hooker, stand next to the following order: For "species 2" of *Calycanthus* we should read 3, if not 4, one Californian, and two if not three of the Atlantic States.

Magnoliaceæ. This order is made to include both the *Wintereæ* and the *Schizandreæ*, according to views with which we are here familiar. As in older works, the seeds of *Magnolia* are said to hang upon a filiform funiculus,—which is by no means the case. What funiculus there is to these nearly sessile seeds is thick; as they separate from the placenta, the copious spiral ducts in their center are stretched out and form the extensile thread. Our *Schizandra* has its character enlarged, to take in *Sphærostemma*, a Japanese species collected in our N. Pacific Expedition connecting the two.

Berberideæ, is made to include *Lardizabaleæ*, which does not concern North America. It is worth noting, however, that the abnormal production of two or more carpels in *Podophyllum* (which, it seems, is not very uncommon, although only lately noticed) goes to confirm this union. The flowers of *Caulophyllum* were better described by the word *luridi* than "*lutei*," and the discovery of the the pulpy arillus to the seeds of *Podophyllum*, attributed in the addenda to A. Gray, belongs to Dr. Torrey, and was first published in the Flora of the State of New York.

Papaveraceæ. The genus *Platystigma* takes in Nuttall's *Meconella*, adding two species, *P. Oreganum* and *P. Californicum*. *Stylophorum* gets enlargement, and too close approximation to *Chelidonium*, by taking in a Himalayan and also a Japanese species, each formerly regarded as of distinct genera. Although not in our way, there is an oversight in the character of Pteridophyllum, the stamens being alternate with, not "opposite" the petals.

Cruciferæ. Nuttall's *Phœnicaulis* is remanded to *Cheiranthus.* *Armoracia* is not referred to *Nasturtium* as we should think most proper, but is left in *Cochlearia.* *Arabis* includes *Turritis*, a view already adopted with us. *Cardamine* takes *Dentaria*, which is hardly necessary, while *Draba* is not allowed to swallow *Erophila.* *Warea* is said to have but one species, instead of two. *Pachypodium*, Nutt. is the name adopted (instead of *Thelypodium*, Endl.), but Lindley's genus of *Apocyneæ* pre-occupies that name. The Californian *Tropidocarpum* is said to have 6 species instead of 2, a typographical error. *Tetrapoma*, is not simply to be reduced (as suggested in addenda) to *Nasturtium palustre*, which, however, sometimes occurs in the tetracarpellary state. *Biscutella*, by including *Dithyrea* of Harvey, gets two American species, *B. Californica* and *B. Wislizeni.*

Caryophyllaceæ. The primary divisions are reduced to the rank of tribes, *Sileneæ*, *Alsineæ*, the latter including the stipulate *Spergula* and *Spergularia*, and *Polycarpeæ*, while the uniovulate *Illecebreæ* proper are to find a place next *Amarantaceæ*, and *Mollugo* and its allies go to the *Ficoideæ* further on,—the distinction between hypogynous and perigynous insertion being kept up as far as possible. As to genera, *Saponaria* and *Lychnis* are restored to their Linnæan limits, and so on. The position of the styles in respect to the sepals is corrected in the addenda as to *Sagina*, but not as to *Stellaria.* There is nothing more to remark as to the related orders, except that in,

Elatineæ, our anomalous Texan species is referred to *Bergia* on account of the pentamerous flowers and the habit, notwithstanding the dehiscence of the fruit. This seems proper, and so the plant must take the name of *Bergia Texana.*

Hypericaceæ. The typical genus is extended to include *Elodes*, a view which we are not inclined to adopt.

Malvaceæ. The order is arranged to include the *Bombaceæ*, but one of the authors has already shown that this is not a tenable arrangement, at least as respects *Cheirodendron* and our Californian *Fremontia.* Otherwise the arrangement proposed in this country is adopted; *Hibiscus*, however, embracing *Abelmoschus* and *Paritium.* Our curious *Thurberia* is suspected to be *Ingenhousia*, and thought to differ from *Gossypium* in its trimerous gynæcium; in the addenda the authors are reminded by Mr. Wright that common Cotton generally has a 3-celled ovary.

Tiliaceæ in their relations to *Flacourtiaceæ* and *Samydeæ* are considerably modified, but this does not concern our U. S. Botany.

Lineæ will require as to *Linum* some modification, on account of a group of tricarpellary, or even dicarpellary species now known in California.

Zygophylleæ. The genus *Tribulus* receives back *Kallstrœmia.* The Texan plant which is so ambiguous between *Guaiacum* and *Porliera*, is here inadvertently referred to both genera. It should, as we suppose, belong to the latter.

Geraniaceæ. The comprehensive, Jussiæan view of the order will doubtless prevail; but we cannot quite be persuaded that *Tropæolum* is as near to *Pelargonium* as to *Limnanthes.* The cryptopetalous or bud-fertilized flowers of *Impatiens* are not noticed; those of *Oxalis* are, but not the dimorphism or trimorphism of the open petaliferous blossoms.

Rutaceæ, enlarged more than ordinarily, to include the *Aurantieæ.* It may be incidentally remarked that Mr. Mann's new Hawaiian genus *Platydesma*, taken up in addenda, should have been placed next to *Medicosma*, to which it is most nearly related. Also, that it is through some misapprehension that the present writer is said in the addenda to have found 1 to 5 ovules in *Skimmia*; he never saw more than one.

Simarubeæ. Here our authors happily place *Suriana* and *Cneoridium*, Hook. f., a new genus founded on *Pitavia dumosa* of California, which Dr. Torrey had before indicated, but without completing the separation or detecting the true relationship.

Ilicineæ, placed between *Olacineæ* and *Celastrineæ*, are yet thought to be most allied to *Ebenaceæ* among the *Corollifloræ. Prinos* is joined to *Ilex*, according to the view long since adopted and carried out with us.

Celastrineæ. Celastrus is said to have a few North American species: we know only one.

Ampelideæ. Vitis is made to include not only *Cissus* but *Ampelopsis*, which, in a comprehensive view, cannot well be objected to.

Leguminosæ comprise 399 genera, brought up to a few over 400 in the addenda, under 3 suborders and 23 tribes. Reverting to his earliest view, Bentham's *Microlotus* section of *Hosackia* is remanded to *Lotus.* The species may, in a general view, be inseparable from *Lotus*, but they are quite as much so from *Hosackia*, and here geographical considerations may as well govern the case. *Lathyrus* is properly made to include *Orobus*, and of course Nuttall's *Astrophia* also, which had been already referred to it by Endlicher. Both *Amphicarpæa* and *Apios* prove to be genera of some extent, having Himalayan species. *Galactia* takes in *Collæa*, which comes into our southwestern borders. *Cæsalpinia* takes in not only various things which had been separated, but also *Guilandina.*

Rosaceæ. Here the primary groups which have ranked at least as suborders are reduced to tribes, and these extended to ten, the *Chrysobalaneæ* being one. *Amygdalus*, &c., being merged in *Prunus*, this tribe is called *Pruneæ*,—a needless change, as even the order *Onagrariæ* is allowed to retain that name, although *Onagra* has been merged in *Œnothera* ever since the days of Linnæus. On account of the evident albumen in the seed and the habit, *Spiræa opulifolia* is transferred to *Neillia*, an eastern Asiatic genus,—a change which we hesitate to adopt. To *Gillenia* is attributed imbricated petals, whereas they are convolute, but so we find those of *Spiræa Aruncus* to be. *Potentilla* is taken in so enlarged a sense as to include not only *Sibbaldia*, which seems inevitable, but also *Horkelia* and *Ivesia.* *Sanguisorba* is absorbed in *Poterium*, and Nuttall's *Peraphyllum* is regarded as a digynous *Amelanchier.*

Saxifrageæ. Here, again, the so-called suborders are reduced to tribes, and the family is made very comprehensive, including even the *Ribesieæ* (which name there is hardly good reason for adopting in place of *Grossularieæ*), and is placed immediately after *Rosaceæ.* By writing the original name *Saxifrageæ*, the authors fall into the needless difficulty of having precisely the same name both for the order and the tribe. We do not make out the ground of their obvious dislike to the termination *aceæ*, which is manifestly called for in the present instance. In the synopsis, *Rodgersia* has lost its *d*, and *Boykinia* is credited with double its actual number of stamens. The sixth section, *Isomeria*, of *Saxifraga*, is superfluous, and belongs mainly to *Boykinia.* In the second line of the character of *Astilbe*, a "*vel*" should be supplied after "liber." *Lithophragma* is, not unnaturally, referred back to *Tellima*, but is perhaps better as a distinct genus. A very interesting new genus from California, *Bolandra*, Gray, recently published, will find a place near *Tolmiæa*, *Tiarella*, and *Tellima.* *Parnassia* is incorporated into this tribe, next to *Lepuropetalon*, and the position of the stigmas relative to the placentæ is corrected in the addenda.

Crassulaceæ. Here we have only to remark that *Echeveria* is reduced to *Cotyledon.*

Droseraceæ, on account of a slight adnation in some species, are brought into the neighborhood of *Saxifragaceæ;* but in *Dionæa*, where this is perhaps most pronounced, while the calyx-tube is said to be "*basi ovarii adnatus*," the petals and stamens are described as hypogynous,—statements which are not quite congruous.

Halorageæ, adopted as an order and placed at some distance from *Onagrarieæ*, contain *Callitriche*, probably because one knows no other more fitting place for it. The great orders *Myrtaceæ* and *Melastomaceæ* require no mention in the present connection.

Lythrarieæ. *Didiplis*, Raf., 1833, is adopted for *Hypobrichia*, M. A. Curtis, but the single species may as well be referred to *Ammannia.*

Onagrarieæ. In the seeds of some species of *Jussiæa*, an investment derived from the pericarp is confounded with the testa; and Rothrock's very distinct genus *Heterogaura* is adopted.

Passifloreæ. The tendrils of *Passiflora* are inadvertently said to be lateral, instead of axillary. Our authors refer *Papayaceæ* directly to this order.

Cucurbitaceæ. The genus *Trianosperma* of Martius gets its name from *Bryonia*, section *Trianosperma* (not "*Trianospermum*") in Torrey and Gray's Flora. The original, *T. Boykinii*, is abundantly different from *Bryonia*, but is not altogether congruous with the West Indian *Cionandra* of Grisebach. If there be really "fifteen species" of *Echinocystis*, and most of them pentamerous in the calyx and corolla, then the "interdum 6-meri," noted at the close of the character, may suffice. But apparently the original species is always hexamerous. *S. Oreganus* is certainly *Megarrhiza*, which we are not disposed to follow Naudin in regarding as *Echinocystis*, and we fancy that all the species with several parietal and ascending ovules, which are referred to in the generic character, are nearer to *Elaterium* than to genuine *Echinocystis.* This third tribe, also, may need reconstruction. *Cyclanthera* is in our view monocarpellary, and its ovules horizontal. The second section of *Sicyos*, *Sicyocarya*, is misprinted *Sicyocarpa.*

Datisceæ. We were prepared for the reduction of *Tricerastes*, Presl., to the typical genus, where it becomes *Datisca glomerata.*

The *Cacteæ* are here arranged according to views intermediate between those of Salm-Dyck and those of Engelmann.

Under the old Jussiæan name of *Ficoideæ* (which it were better to be rid of) our authors have assembled *Mesembryanthemum* and its near relatives, such quasi-Portulaceous plants as *Sesuvium*, *Trianthema*, &c., the *Mollugineæ*, and some genera which have of late been referred rather to *Phytolaccaceæ*, the connecting links, indeed, of several Caryophyllineous and Portulacaceous groups.

The *Umbelliferæ*, which were in a most unsatisfactory state, have been wholly re-arranged, and reduced to a much more practicable form; but it does not seem possible to make the genera altogether satisfactory. Without sketching the new arrangement, we will merely refer to the North American genera which are affected by it. The vittæ, whether single or more numerous in the intervals, being much relied on, our *Tauschia Texana* is referred to *Eulophus.* But *Eulophus* itself is likely to be merged in *Araccacia.* *Deweya*, so merged in this work, proves however to have some good characters, which have recently been pointed out in another place (Proceed. Amer. Acad. June, 1867), and, strengthened by two additional species, is likely to stand. *Apium* is made to include both *Helosciadium* and *Leptocaulis*, the species of which are yet to be re-examined and re-settled; but we have elsewhere assigned reasons why it cannot take in our species of *Sium* proper, as Bentham and Hooker propose. *Carum* is immensely enlarged, and to it is referred *Zizia aurea*, with wingless fruit (the relations of which to *Thaspium* still require investigation), and *Edosmia*, Nutt., a sort of *Bunium*, of which there is now a second Californian species. *Pimpinella* gets a representative in the Atlantic States in *P. integerrima* (*Zizia integerrima*), and in the paper above referred to we have added a Californian one, *P. apiodora.* The Texan *Daucosma* is referred to *Dissopleura* (*D. lacimiata.*) Nuttall's *Glycosma* (now also represented by two species) is merged in *Myrrhis.* *Phellopterus*, probably anticipated by the name *Glehnia*, as we have previously remarked, is founded on our *Cymopterus? littoralis* of the western North American and the northeastern Asiatic shores. *Ligusticum* comprises *Cynapium*, Nutt., and the plants referred to *Conioselinum* are unsatisfactorily divided between this genus and *Selinum.* *Peucedanum* is the name adopted for the most comprehensive group of the single-winged species, including *Pastinaca*, *Tiedemannia*, *Archemora* and *Euryptera.* Nuttall's *Leptotænia* is kept up; but we have elsewhere proposed to reduce it to *Ferula.* Nuttall's *Atrema* justly becomes *Bifora Americana.* *Ammoselinum*, Torr. and

Gray, is given in the addenda; but we take it to be a long-fruited *Apium.*

Under *Cornaceæ* we have only to note that *Benthamia* is reduced to a section of *Cornus* little different from that to which *C. florida* belongs: also that *Garrya* finds its resting place here.

A. G.

4. *Traité Général de Botanique descriptive et analytique.* 1^me^ *Partie, Abrégé d'Organographie, d'Anatomie, et de Physiologie.* 2^me^ *Partie, Iconographie, Description et Histoire des Familles.* Par Mm. LeMaout and J. Decaisne. *Ouvrage contenant* 5,500 *figures dessinies par* Mm. L. Steinheil *et* A. Riocreux. Paris. Firmin Didot et Frères, Fils et Cie. 1868. pp. 745, small folio.—A copy of this work, from one of the authors, has reached us barely in time for this brief notice of it in the present place. It is a most handsome and beautifully printed volume, a compendium of all botany (phænogamous and cryptogamous), as the title shows, illustrated by a profusion of attractive wood cuts from original drawings, a part of which, however, have already done service in its precursor, LeMaout's *Atlas Elémentaire.* To all teachers a complete treasure, both for the text and the illustrations, is here richly provided for their lectures and lessons,—illustrations which may be depended on for accuracy. Such a large and fresh stock of figures is an invaluable acquisition to the teacher's resources; and the text we presume to be equally reliable. It is published in Paris at a very moderate price for such a volume, in itself a library.

A. G.

5. *Gray's Manual of the Botany of the Northern United States. Fifth Edition, Second Issue,* 1868.—A prefatory note states that, "in the present issue many small corrections, typographical and other, have been made throughout the volume, as well as more considerable alterations on pages 479, 480, 564; an omission of the proper acknowledgment for the article on Sparganium is supplied on p. 481; and additional species, with a few more extended emendations, are given on pages 679–682." The sheet containing the addenda will be supplied by mail to any who have the first issue, in 1867, upon application, enclosing a two-penny stamp, either to the publishers or to the author.

A. G.

6. *Illustrations of the Genus Carex, by* Francis Boott, M.D. Part IV, Tab. 412–600. 1867.—We extract the following from J. D. Hooker's Preface. "The publication of this part is wholly due to the munificence of Mrs. Boott, who issues it as a tribute to the memory of her late husband,—an earnest of his abiding zeal in this elucidation of his favorite genus, and of his love of science and desire to promote it. In the same liberal spirit Mrs. Boott (in 1865) presented the whole of Dr. Boott's botanical collections, manuscripts and drawings, to the Royal Gardens of Kew, then under the directorship of her husband's earliest surviving friend, the late Sir W. J. Hooker." . . . . .

What a noble tribute is this volume to the memory of her husband; others may rear the stately monument or storied urn to near and dear friends, but here is a monument more enduring than marble, and more eloquent than studied phrase or glowing verse.

The tables are numbered 412 to 600, illustrating each plant in full size, and drawn with great beauty and spirit, with ample dissections of the parts, following the "Explicatio Tabularium" as laid down in Part I. These 189 plates illustrate 124 species. Forty five of them are found in North America, viz:—

- Carex Halleriana, *Asso.*
  - pedunculata, *Muhl.*
  - aperta, *Boott.*
  - bicolor, *All.*
  - circinata, *Meyer.*
  - Buxbaumii, *Wahl.*
  - Gmelini, *Hook.*
  - fulva, *Good.*
  - pallescens, *L.*
  - Pseudo-Cyperus, *L.*
    - and var. comosa.
  - stylosa, *Meyer.*
  - Breweri, *Boott.*
  - leiocarpa, *Meyer.*
  - mirata, *Dew.* in Wood, not in Sill. Jour.
  - gynocrates, *Wormsk.*
  - tenuiflora, *Wahl.*
  - teretiuscula, *Good.*
    - var. major (Ehrhartiana).
    - var. ramosa (prasina, *Dew.*).
  - polytrichoides, *Muhl.*
  - panicea, *L.*
  - nigricans, *Meyer.*
  - Pyrenaica, *Wahl.*
  - vaginata, *Tausch.*
  - heleonastes, *Ehrh.*
  - glareosa, *Wahl.*
    - var. C. ursina, *Dew.*
  - canescens, *L.*
- Carex arcta, *Boott.*
  - maritima, *Vahl.*
  - ampullacea, *Good.*
  - compacta, *R. Br.*
  - physocarpa, *Presl.*
  - rupestris, *All.* and var.
  - scabrata, *Schw.*
  - Sitchensis, *Prescott.*
  - viridula, *Michx.*
  - salina, *Wahl.* (ambusta, *Boott*, Ill. 172).
    - var. minor (lanceata, *Dew.*)
    - var. Hoppneri, *Boott.*
  - obesa, *All.*, var.
  - vesicaria, *L.*
  - lævigata, *Smith.*
  - aquatilis, *Wahl.*
    - var. minor.
  - acuta, *L.*, var.
  - vulgaris, *Fries.*
    - var. alpina (C. rigida, *Good*).
  - var. hyperborea (C. Bigelovii), *Schw.* and *Torr.*
  - angustata, *Boott.*
    - var. (C. stricta, *Dew.*)
    - var. (C. strictior, *Dew.*)
  - microglochin, *Wahl.*
  - Jamesii, *Torr.*
  - laciniata, *Boott.*

Of these, *Carex Breweri*, belonging to the Phyllostachys group, and *Carex laciniata*, of the Acutæ group, are here first described. This last plant was figured as *C. Wilkesii*, Torr. ined. U. S. Ex. Expedit. The descriptions are numbered from 292 to 524. (*C. Hartwegii* and *C. Mexicana* are both referred by the learned author in Herb. Hook. to *C. polystachya*, *β*, Boott, or *C. cladostachya*, Wall.) Twelve species are simply numbered, without descriptions, and among these, to the regret of American Botanists, are *C. ampullacea*, *C. vesicaria* and *C. viridula*, Michx.

Eighty-four drawings, 601–684 in the Herbarium at Kew, are referred to as illustrating descriptions 417–484, sixty-nine species; of which eighteen are North American, viz:—

Carex cæspitosa, *L.* var. filifolia.
capillaris, *L.*
capitata, *L.*
elongata, *L.*
fœtida, *Allioni.*
globosa, *Boott.*
juncea *Willd.*
lagopina, *Wahl.*
leiorhyncha, *Meyer.*
leporina, *L.*
Carex micropoda, *Meyer.*
muricata, *L.*
β gracilis. (C. Hookeriana.)
nigella, *Boott.*
obtusata, *Liljeblad.*
pauciflora, *Lightfoot.*
podocarpa, *R. Br.*
remota, *L.*
stenophylla, *Wahl.*

The descriptions 486–524, 39 species, have neither plates nor drawings to illustrate them. Thirteen of these are North American, viz:—

Carex chordorhiza, *Ehrh.*
extensa, *Good.*
holostoma, *Drej.*
incurva, *Lightfoot.*
Mertensii, *Prescott.*
nardina, *Fries.* (C. Hepburnii, *Boott*).
Norvegica, *Wahl.*
Carex paludosa, *Good.*
pedata, *Wahl.*
petricosa, *Dew.*
præcox, *Jacq.*
triquetra, *Boott.*
vitilis, *Fries.*
α. (C. Persoonii).
β. sphærostachya.

Under *C. triquetra* reference is made to plate 417. That number figures *C. alligata*, a very different species. *C. triquetra*, a Californian plant, resembles *C. Halleriana*, Tab. 415–416, and no figure of it is given.

Thus, of the North American species, 45 are illustrated by plates, 18 by drawings in the Kew herbarium, and 13 have descriptions only, making 76 species in all.

A small tribute of affection and gratitude American Botanists might well pay to the memory of Dr. Boott by publishing the illustrations now deposited in the herbarium at Kew. We propose to give a complete enumeration of the North American species described in the four parts of this work, with notices of those omitted, in some subsequent number. S. T. O.

7. *The Variation of Animals and Plants under Domestication;* by CHARLES DARWIN, M.A., F.R.S., etc. 2 vols., with illustrations. 8vo. London, Murray, 1868.—At the present moment we can only announce that an American reprint of this important work is just issued by Orange Judd & Co., New York, the publishers of the American Agriculturist, at less than half the cost here of the English copies. To this edition some words of preface, corrections, and additions have been contributed by the author himself.

8. *Critical remarks on the Halcyonoid Polyps in the Museum of Yale College, with Descriptions of new Genera;* by A. E. VERRILL. *Muricea.*—This genus has been very judiciously restricted by Dr. Kölliker* to species like *M. muricata* (*spicifera* Lamx.), having the cells covered with imbricated, fusiform spicula.

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* Icones Histiologicæ, ii, p. 135, 1866.

For *M. placomus* and similar forms he has established the genus *Paramuricea*, and for *M. cerea* Dana, and allied species, the well characterized genus *Echinogorgia*. In Prof. Dana's Zoöphytes the first two species of *Muricea* alone belong to the restricted genus, but his *Gorgonia tuberculata* Esper should be added. The first four species in Milne Edwards's Coralliaires are true *Muriceæ*. Dr. Kölliker admits seven species. In the Museum of Yale College there are now twenty one species of true *Muricea*. Of these, three came from the Indo-Pacific fauna, three from the Carribean, and fifteen from the Panamic. Of the latter, nine species are new and are now being published by the writer.* To this number must be added *M. horrida* Mobius, of Peru; three West Indian species; *M. pendula* Verrill, of S. Carolina; *M. tuberculata* Köll., *M. vatricosa* K., and *M. humosa* K., to complete the whole number of species now known.

Gonigoria clavata Gray, Proc. Zool. Soc. 1851, p. 124, is doubtless also a young *Muricea*.

Muricea muricata Verrill = Gorgonia muricata Pallas; Ellis and Sol., = Muricea spicifera Lamx. Exp. Meth., Tab. 71, f. 1 & 2, 1821.

There appears to be no sufficient reason for rejecting the original name of this common West Indian species.

M. elegans Duch. and Mich., Corall. des Antilles, p. 19, 1860, = M. elongata Dana (non Lamoroux).

If the original *M. elongata* be correctly described and figured, it cannot be this species, but rather an *Acis*. *M. elegans* Verrill, Bulletin M. C. Z., p. 36, 1864, is a different species, since changed to *M. pendula* V., in Mem. Boston Soc. Nat. Hist., i, p. 45, July, 1864.

M. laxa Verrill, Bulletin M. C. Z., 1864, is a distinct Florida species.

M. robusta Verrill, loc. cit., p. 36; and Proc. Bost. Soc. Nat. Hist., 1866, p. 329.

The supposed white variety, formerly included under this species, proves to be the following distinct species, common at Panama.

M. albida. This is characterized by its somewhat appressed cells with an elongated and flattened lower lip; its thick branches; and long, acute, fusiform, very thorny spicula.

M. hebes Verrill, op. cit.

The supposed purple variety, formerly included with this species, likewise proves to be a distinct and common Panama species, where the typical form is also common.

M. purpurea, is characterized not only by its deep purple color, known in no other species, but by its short appressed cells, thick, often clavate branches, and short, blunt spicula. It also grows much larger than *M. hebes*, and branches dichotomously.

Muricea appressa Verrill, Bulletin M. C. Z., Jan. 1864, = Eunicea Tabogensis Duch. and Mich., Supl. Corall. Antilles, p. 171, Tab. iii, f. 5, 6, 1864.

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* Transactions of the Connecticut Academy of Arts and Sciences, vol. i, part 2. New Haven.

Although the exact date of the latter work is unknown, it could not have been until after May, since, on page 7, there is a foot-note dated "Turin, 17 Mai."

Muricea flexuosa Verrill, = *Lissogorgia flexuosa* V., Proc. Essex Inst., iv, p. 187, 1865.

This species appears to be referable to *Muricea,* but, with other East Indian species, forms a distinct section of the genus, characterized by a very thin cœnenchyma, composed chiefly of large fusiform spicula, from among which the small cells rise at right angles to the surface, thus approaching *Acis,* but differing from the latter in having the cells covered by fusiform spicula.

Muricea nitida Verrill.

This elegant species is allied to the last; but differs in the bright purplish-red color, and larger size of the spicula, which compose, almost exclusively, the cœnenchyma. These are relatively very large, long fusiform, blunt at the ends, often crooked, the surface finely papillose and shining. Those of the polyps are bright yellow. The cells are small, verruciform, and covered by small fusiform spicula, branches slender, axis light yellowish brown, horn-like.

Ebon Island, Central Pacific, on *Stylaster elegans* Verrill,—(H. Mann).

Anthogorgia divaricata Verrill, = Muricea divaricata V., Proc. Essex Inst., iv, p. 188, 1865, pl. 5, fig. 5 and 6.

The genus *Anthogorgia* is now proposed for this remarkable form. It is characterized by very prominent, tubular cells, eight-rayed at summit; a thin cœnenchyma containing imbedded fusiform spicula; those of the cells long, fusiform, thorny, imbedded at various angles in the surface, but not imbricated.

Paramuricea cancellata Verrill, = Gorgonia cancellata Dana, 1846, = Villogorgia nigresens Duch. and M., 1860, = Lissogorgia flabellum Verrill, 1864 (non Antipathes flabellum Pallas; ? A. flabellum Esper. Tab. i.), = Paramuricea nigrescens Köll., 1866, = Echinogorgia flabellum Verrill, this Jour. 1866, vol. xlii, p. 283.

This is unquestionably Dana's species, and identical with *Paramuricea nigrescens* Köll., who has sent me spicula from an authentic specimen. Esper's name was erroneous, having been pre-occupied in both *Gorgonia* and *Antipathes.* Therefore, if his *A. flabellum* proves to be this species, Dana's name should still have preference. The reference by Prof. Dana to Esper's *G. pseudo-antipathes* proves to be wrong, for Dr. Kölliker has found that the latter is a *Gorgonella,* but he has, by a similar error, referred Dana's species to this as a synonym. The genus *Lissogorgia,* founded on *P. cancellata,* must be dropped, unless the latter should prove to be generically distinct from *P. placomus,* the type of *Paramuricea,* from which it differs widely in appearance, though agreeing pretty well in the form of the spicula. The characters given to *Villogorgia* Duch. and Mich., are entirely erroneous, and the name has a false signification.

Genus *Heteorogorgia* Verrill.—This genus has been established upon two curious species from Panama. It is characterized by a horny axis; smooth cœnenchyma, with very small, spindle-shaped spicula; verruciform cells, armed at the summit with longer, slender, projecting and divergent, sharp spicula, which are often much bent.

H. verrucosa V., is a low species, with few clavate branches and prominent verrucose cells.

H. tortuosa V., has smaller, crooked, irregular branches; smaller, less prominent, and scattered cells; and grows to the height of six inches or more.

Psammogorgia arbuscula Verrill, = Echinogorgia arbuscula Verrill, Proc. Bost. Soc. N. Hist., 1866, p. 326.—The genus *Psammogorgia*, proposed for this species, is characterized by a rather thick cœnenchyma, with the surface granulated by the numerous very small, rough spicula. These are of several forms, but mostly short, thick, blunt spindles, very strongly papillose, and thorny; others are irregular, as broad as long, very thorny; some are pretty regular stars with five, six, or more, rough rays. The cells are either somewhat prominent or flat, and scattered on all sides.

Astrogorgia Sinensis Verrill, = Muricea Sinensis V., Proc. Essex Inst., 1865, p. 187, Pl. 5, f. 5, 5a.—This genus is allied to the last, and like it has a granulated surface, and the cells scattered on all sides, and usually verruciform. The spicula of the cœnenchyma are, however, very different, being nearly all long, fusiform, sharp, warty "spindles" of various sizes. In alcoholic specimens the tentacles are not wholly retracted, but form a low cone, covered by the conspicuous spicula at the bases of the tentacles.

Juncella extans Verrill, Bulletin M. C. Z., Jan., 1864, p. 37, = J. flagellum Johnston, Ann. and Mag. Nat. Hist. 14, p. 142, Aug. 1864.

Plexaura suffruticosa Edw. and Haime, = Gorgonia suffruticosa Dana.—An examination of the spicula of this species proves it to be a true *Plexaura.*

Plexaura spicifera Verrill, = Gorgonia spicifera Dana.—Common at Aspinwall, (F. H. Bradley, Col. Totten).

Plexaura crassa Verrill, Bulletin M. C. Z., 1864, = Gorgonia crassa Ellis and Sol. (non Dana).—This species is not the *Plexaurella crassa* Kölliker, which appears to be the *P. turgida* Verrill, l. c. (?Ehr. sp.), but whether the latter be really Ehrenberg's species cannot be ascertained without an examination of the original specimens.

Plexaura reticulata (?Ehr.) Philippi, Wieg. Arch., p. 119, 1866. Mr. F. H. Bradley collected several specimens of this species at Callao. In microscopic structure it is a *Gorgonia* Köll., but the name, *G. reticulata*, has already been used, and is inappropriate for this species, hence the following name is proposed for it:

Gorgonia (*Litigorgia*) *Peruviana* Verrill, is characterized by its very ramulous, low, shrubby growth, the branchlets short, crooked, often slightly coalescent, the terminal ones subpinnate. Cœnenchyma rather thick, cells small, flat, scattered. Color whitish; height 4 to 6 inches.

Genus *Gorgonia.*—Dr. Kölliker has reunited all the Gorgonaceæ with horny axis to *Gorgonia,* in which he forms three sections, characterized by the spicula:—

1st. *Species having only spindles.* This includes a few species of *Pterogorgia* Ehr., *Rhipidogorgia* Val., *Leptogorgia* Edw., *Lophogorgia* Edw., etc.

2d. *Species having spindles and crescent-shaped or bracket-shaped spicula* ("*Klammern*"). This corresponds nearly with *Pterogorgia* Ehr., and includes *Xiphigorgia, Pterogorgia* and *Hymenogorgia* of Edwards, and *Rhipidogorgia flabellum* Val.

3d. *Species having a peculiar external layer of club-shaped spicula.* This includes the typical species of *Gorgonia,* as restricted by Edwards.

Among the 17 species which are in the Museum of Yale College from the west coast of America, not a single one can be referred to the second or third sections of the genus. The species of the second section are very numerous from the West Indies and Atlantic coasts of America. Those of the third section are mostly Mediterranean and African, so far as known. The Panamic species divide naturally into two groups, containing about equal numbers.

1st. Species having only warty "double-spindles" in the cœnenchyma, which are of two sorts, longer and shorter.

2d. Species having "double-spindles" and "double-wheels."

In each of these groups the modes of branching are various, and there are species with either flat or raised cells. These groups, like the 2d and 3d of Kölliker's, seem sufficiently marked and distinct to merit recognition either as genera or, at least, as sub-genera, and therefore I have proposed the following names:

Litigorgia for the first group, including *G. media* Verrill, and *G. Agassizii* V., with reticulated branches; *G. lævis* V., with virgate; *G. Floræ* V., with bipinnate; *G. ramulus* Val., *G. diffusa* Verrill, *G. pumila* V., and other species with pinnate ones.

Eugorgia for the 2d group. These species all have a distinctly granulose surface, owing to the large number of small naked spicula, the cells are mostly in two lateral bands. It includes *G. ampla* Verrill, *G. nobilis* V., *G. rigida* V., *G. flexilis* V., *G. cuspidata* V., and *G. Bradleyi* V., with long branches, often virgate or flabelliform; *G. stenobrachis* Val., with reticulated branchlets; *G. Daniana* V., and *G. Mexicana* V., with bipinnate ones, and prominent cells.

G. (*Litigorgia*) *Adamsi* Verrill, = Rhipidogorgia ventalina Duch. and Mich., Supl., (after May) 1864, p. 90, Tab. iii, f. 3. (non Gorgonia ventalina Pallas).

G. (*Litigorgia*) *lævis* Verrill, Proc. B. S. N. H., p. 327, 1866, = Lophogorgia alba Duch. and Mich., op. cit., p. 19, Tab. iv, fig. 2, 1864 (non Gorgonia alba Lam.).

G. (*Eugorgia*) *Mexicana* Verrill, = Lophogorgia aurantiaca Horn, Proc. Phil Acad. Nat. Sci., 1860, p. 233; Gorgonia aurantiaca Verrill, Bull. M. C. Z., p. 33, (non Gorgonia aurantiaca Edw., Corall., 1857).

A fine, large specimen of this beautiful species, from La Paz, Gulf of California, is in the collection.

Xiphigorgia citrina Verrill, Bulletin M. C. Z., 1864, = Gorgonia citrina Esper, = X. Americana D. and M., Supl., 1864, = Gorgonia citrina Köll.; ? Pterogorgia citrina D. and M., Supl.

Erythropodium Pacificum Verrill, = Sympodium Pacificum, Verrill, Proc. Bost. Soc. N. H., 1866, p. 329.

Telesto trichostemma Verrill, = Gorgonia trichostemma Dana, Zoöph. p. 665, Pl. 59, f. 3, 3a, 3b.—An examination of the original specimen of this species shows that it is a parasitic polyp (probably a *Telesto*) allied to *Cornularia*, covering in the lower part the dead axis of an *Antipathes*, but in the upper part rising up into slender, hollow branches of its own.

Cyathopodium tenue Verrill, = Allopora tenuis Dana, Zoöph., p. 630, Pl. 59, fig. 5, 1846.—This new genus is proposed for the remarkable little polyp, rightly described by Prof. Dana as closely allied to *Tubipora*. It is in fact a Tubipora-like polyp, with short, cup-shaped tubes, connected by narrow calcareous stolons, which correspond to the tranverse plates of *Tubipora*, and from which the new buds arise.

9. *Notice of the Corals and Echinoderms collected by Prof. C. F. Hartt, at the Abrolhos Reefs, Province of Bahia, Brazil*, (with one plate); by A. E. VERRILL. (From the Transactions of the Connecticut Academy of Arts and Science, vol. i. New Haven, Feb. 1868).—In this paper 19 species of corals and 16 of Echinoderms are enumerated as collected on the Brazilian coast by Mr. Hartt. The Echinoderms are mostly West Indian species, yet three are described as new (*Echinaster crassispina*, *Asterias Atlantica*, and *Thyone Braziliensis*), and notes on the localities and stations of most of the species are given by Mr. Hartt. The occurrence of *Oreaster gigas* Lutk., so far south, is noteworthy. Of corals, nearly all the species are peculiar to Brazil. The following are described as new:* *Siderastræa stellata*, *Favia leptophylla*, *F. gravida*, *F. conferta*, *Acanthastræa Braziliensis*, *Heliastræa aperta*, *Mussa Harttii*, *Symphyllia Harttii*, *Porites solida*, *Pterogorgia gracilis*, *Millepora nitida*, *M. Braziliensis*, *M. alcicornis*, var. *cellulosa*.

Mr. Hartt furnishes this account of the Brazilian coral-reefs and the distribution of the species:

"The following general conclusions may be added with reference to the coral-fauna of Brazil.

"1st. The species are, as Prof. Verrill above remarks, almost without exception, peculiar to the Brazilian coast, along which they have quite a wide distribution; the most of the species ranging from Cape St. Roque to Cape Frio, which seems to be the southern limit of the fauna. In the Bay of Rio de Janeiro, where the conditions appear to be very favorable for coral growth, I have been able to find only one or two species of madreporarian corals, and these were *Astrangiæ.*

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* Brief descriptions of several of these new species appeared also in the March No. of the American Naturalist, Salem, Mass., accompanying an account by Mr. *Hartt* of his trip to the Brazilian coast, which is also continued in the April No., with an interesting description of the coral reefs.

"2d. The Brazilian fauna bears a close resemblance to the West Indian, and there are many representative species. Thus the *Siderastræa stellata*, *Heliastræa aperta*, *Favia gravida* and *Porites solida*, are representatives of West Indian forms; and among the Halcyonoids, *Hymenogorgia* represents the *Rhipidogorgiæ* of the West Indian fauna.

"3d. The absence, in the Brazilian fauna, of the genera *Madrepora*, *Mæandrina*, *Diploria*, *Manicina*, *Cladocora*, *Oculina*, genera so characteristic of the West Indian fauna, is noteworthy.

"4th. The Brazilian corals form extensive reefs, which occur along the coast, from the "Roccas," north of Cape St. Roque, to the Abrolhos. The genera which contribute most to the reefs are *Acanthastræa*, *Favia*, *Heliastræa*, *Siderastræa*, *Porites*, and *Millepora*, but the *Mussa* and other species add a more or less notable share.

"South of the Abrolhos region, there are no known coral reefs. Very extensive ones occur in the Abrolhos region, at Itacolumi, Porto Seguro, Sta. Cruz, and in the vicinity of Camamú, and elsewhere south of Bahia. In the Bay of Bahia are large coral banks, and off the town of Maceiò, in the province of Alagóas, there are large irregular coral patches, uncovered at low tide, which are seen extending northward along the coast toward Pernambuco. Coral patches occur frequently on the coast farther north, and the extensive reef of the Roccas, in the latitude of the island of Fernando de Noronha, is formed of coral.

"Around the Abrolhos Islands are *fringing* reefs. Between these Islands and the shore is a large area of shallow sea, full of irregular reefs. On the Brazilian shore, in open water, the corals grow in small patches on the sea-bottom, and rise vertically to the surface like towers. These structures are termed, in Brazil, *chapeirões* (sing. *chapeirão*). In some instances they are only a few yards in diameter, while their height may be 40–50 feet or more. These *chapeirões* usually grow close together, and sometimes coalesce to form reefs of several square miles in area. The larger reefs are usually surrounded by chapeirões. Ordinarily, the reefs reach a level a little above low-tide. They are remarkably level topped. Occasionally sand is heaped upon them, and they become islands, but instances of this kind are very rare."

10. *Notice of a Collection of Echinoderms from La Paz, Lower California, with a Description of a new Genus of Starfishes;* by A. E. Verrill. From Transactions of the Conn. Academy of Arts and Sciences, vol. i, April, 1868.—This list furnishes additional information concerning the fauna of the Gulf of California. Several rare species are enumerated and *Tripneustes depressus* A. Ag. is, for the first time, described, and also a new genus and species of starfish, *Amblyaster insignis* Verrill.

The genus *Amblyaster* is allied to *Oreaster*, and still more so to *Nidorellia* Gray. It is depressed, five-rayed, covered on both sides, with large, polygonal plates, nearly all of those of the back bearing large, conical spines, which form three rows on the rays. The marginal plates alternately approach and recede from the margin, and are alternately smooth and spine-bearing.

11. *On the Families of the Raniform Anura.* From the Journal of the Philadelphia Academy of Arts and Sciences; by E. D. Cope. (Received Feb. 1868, without date.)—The arrangement and structural characters of the genera of Raniformia, which are here divided into six families, are well presented in this memoir. Several new genera and species are described, and there are many useful criticisms and important changes in synonymy. The paper is supplemented by remarks upon some structural features of Arcifera, with a revision of the genera allied to Hyla, and descriptions of some new species. V.

12. *On the Spongiæ Ciliatæ as Infusoria Flagellata; or, Observations on the Structure, Animality, and Relationship of Leucosolenia botryoides Bowerbank.* By H. James Clark. Memoirs Boston Society of Natural History. Vol. I, Part III, 4to, with two lithographic plates. Boston, September, 1867.—In this memoir Prof. Clark has described in much detail and beautifully illustrated the internal and external structure of many species of the lower flagellate infusoria, belonging to the genera, *Monas*, *Bicosœca* (gen. nov.), *Codonœca* (gen. nov.), *Codosiga* (gen. nov.), *Salpingœca* (gen. nov.), *Anthophysa*, *Astasia*, *Anisonema*, *Dysteria* and *Pleuronema.* All these are shown to be more or less closely related to the siliceous sponge, *Leucosolenia botryoides*, the structure of which is fully illustrated and described. This sponge is composed of immense numbers of monad-like infusoria arranged side by side in a layer that lines all the cavities. These sponge-monads have, like all the other genera named above, except *Monas*, a sort of membranous collar surrounding the anterior end, and are furnished each with a long slender lash or flagellum corresponding to that of the other genera, and also have two distinct pulsating vesicles, and all other parts much as in *Codosiga* and *Salpingœca*, to both of which it is closely allied. The sponge, in fact, appears to bear a relation to the species of *Salpingœca* and other simple, monad-like infusoria, similar to that which the compound corals bear to the simple *Actiniæ.*

These investigations not only prove the animality of sponges, but show that, at least, those allied to *Leucosolenia* must be referred to the ciliated division of the *Protozoa* instead of Rhizopods, where they have been hitherto placed by Carter and others. V.

13. *Remarks on the Geology of the valley of Mackenzie River, with figures and descriptions of Fossils from that region in the Smithsonian Institution, chiefly collected by the late Robert Kennicott, Esq.;* by F. B. Meek. 53 pages, large 8vo, with 6 lithographic plates. From the Transactions of the Chicago Academy of Sciences, vol. I. Chicago, 1868.—In the introductory account of the Geology of the Mackenzie River, Mr. Meek shows that most of the rock exposures examined along that river, between Clear Water river and the Arctic Ocean, are of Devonian age, and correspond with

the Hamilton formation and Genesee slate of the United States. The slates in some places give rise to brine springs and petroleum. A considerable number of Corals and Brachiopods, and one Cephalopod (Gyroceras Logani) are described as new, and beautifully illustrated. Many others are given as identical, or probably identical, with species already described from the United States and Canada. The new species, also, are mostly allied to Hamilton fossils of the United States. It is thought probable that a continuous band of Devonian rocks, mostly Hamilton, extends in a northwesterly direction from Rock Island, Ill., to the Arctic Ocean, a distance of 2,500 geographical miles in a right line. Some species of fossils from localities near the extreme ends of this belt, or separated by nearly 30° of latitude, are pronounced undoubtedly identical, showing that in paleozoic times marine temperatures were but little influenced by latitude. The excellent typography and plates of this memoir are very creditable to the Chicago Academy and the officers under whose superintendence the first volume of Transactions is now being published. v.

14. *The Fossil Cephalopods of the Museum of Comparative Zoology;* by ALPHEUS HYATT. Bulletin of the Museum of Comparative Zoology, No. 5. 32 pages, 8vo. Cambridge, without date (received Feb., 1868).—This contains lists of the numerous species of Ammonites contained in the Museum of Comparative Zoology from the Lower, Middle, and Upper Lias. The Ammonoids are treated as a distinct order of Cephalopods, and those included in these catalogues are divided into ten families, which are subdivided into numerous new genera. Several new species are also described, and critical synonymy of other species is given. Doubtless many paleontologists will hesitate before adopting all these subdivisions of the great "genus" Ammonites, but the work is evidently the result of a long and careful study of one of the largest series of these fossils to be found in any museum, and may therefore be regarded as approaching as nearly to a true classification as the state of preservation of the specimens will admit. v.

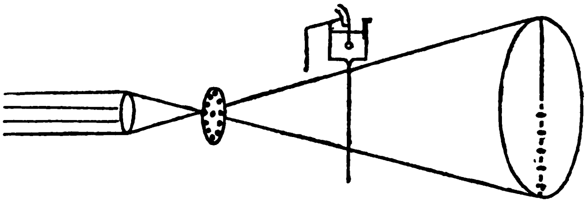
IV. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *On convenient forms of Experiment with fluid jets;* by Prof. FRANCIS H. SMITH (from a communication to J. D. Dana, dated University of Virginia, Feb. 29, 1868).—The following descriptions of some serviceable forms of experiment with fluid jets may be of interest to a few of your readers.

To obtain the water-jet, presently referred to, a small glass funnel was cemented to an opening in the bottom of a bucket. A valve was constructed by wrapping a 3 oz. leaden bullet with buckskin, aud suspending it over the funnel from one end of a lever mounted upon the edge of the bucket. Placing the latter upon a tall tripod, and filling it with water, the operator has control of a satisfactory jet, which he can start and stop at pleasure. This rude apparatus leaves, perhaps, nothing further to be desired in the way of vertically falling jets.

Exp. 1. *Resolution of the jet.*—A large cylindrical beam of sunlight was introduced horizontally into the darkened chamber. The beam was condensed to a focus, with a double-convex lens. Between this focus and a screen, the jet of water was made to fall; a well defined shadow of the jet was thus thrown upon the screen, and it was easy to see a marked difference in the intensity of the shadow of the tranquil and troubled sections. Just at the focus referred to, was placed a circular disc of card-board, rotated by clock-work, and perforated all round, near its margin, with a number of equi-distant holes. When this was properly adjusted and set into rotation, the jet and screen were illuminated by a rapid succession of flashes of light.* Instantly the troubled section of the jet and its shadow was seen to be resolved into vibrating drops. When the flashes followed each other as fast as the drops, the shadows of the latter were stationary on the screen. If the velocity of the disc were now slightly reduced, the shadows slowly descended, and were seen to palpitate from prolateness to oblateness in a surprisingly distinct manner. If the disc be urged to greater speed, the shadows of the drops appear to ascend, according to a well known optical relation. It may be added, that by changing the relative distances of the jet and screen from the illuminating focus, we may make the shadows of the drops so large as to be seen without difficulty from the remotest parts of the largest lecture-room. I need not say that the electric lamp would furnish, in respect of steadiness, a better means of illumination than the sun.

This experiment was first tried by me in October 1867, with a jet of quicksilver, strongly illuminated. The image of the jet was formed on the screen, and suitably interrupted at short intervals of time. The result was satisfactory, but was liable to the objections that the image was inverted.



Exp. 2.—The jet was chastened into greater regularity of structure by the sound of a monochord, tuned to tension with it, or more simply by receiving its troubled section upon a resonant surface, so placed that its tremors were transmitted to the reservoir through the legs of the tripod. The phenomena before described were now more marked, the intermittent light enabling us to trace in detail the influence of the sound, in abridging the tranquil section of the jet, and causing incipient swellings and strictures high up upon the latter. The reflection of sonorous beats also may be more narrowly observed by this form of experiment.

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* When the disc is spinning very rapidly, the illumination of the screen seems to be continuous, but a white wand or string, or a fiddle-bow, shaken in the light, will demonstrate to the spectators its interrupted character. When the hand, with its fingers extended, is moved rapidly to and fro in the light, a monstrous appearance is presented, which must be seen to be appreciated. The appearance also of a stretched cord vibrated transversely in the intermittent cone of light, is instructive. Its *apparent* wavings, the velocity of the perforated disc being kept uniform, change of course with the tension of the cord. When the vibrating cord appears stationary, its time of vibration is a multiple or sub-multiple of the interval of the flashes of light. As it is not difficult to decide this "indetermination," we have here, it appears, a method of determining the number of transverse vibrations, per second, of a tense cord.

Exp. 3.—The jet was received in its smooth section upon a polished circular metallic plate, considerably wider than the jet, and one of Savart's liquid sheets, ten inches in diameter, was formed. When the unisonant monochord was sounded, the sheet was at once abolished. It was interesting to watch the resolution of the curved sheet of water, in the interrupted light, both with and without the aid of the neighboring sound.

Experiments with like results were made with oblique and vertically ascending jets. In all cases the intermittent light invested the results with new interest and instruction. If I am not mistaken, the method here described is far preferable in simplicity, certainty and ease of control, to that of electric flashes from the Leyden Jar, whether used for research, or mere lecture-room illustration.

In reference to gaseous jets, allusion will at present be made only to sonorous flames in tubes.

2. *Resolution of the Sounding flame;* by Prof. F. H. Smith, (ib.)—By those who have no mirrors, lenses or revolving apparatus, and who find a difficulty in properly moving the eyes to and fro before the flame, the intermittent character of the latter, when sounding, may be exhibited by simply shaking a chalk crayon near it, and noting the marked change assumed in the appearance when the flame passes from silence to song.

With a revolving apparatus, however, the following form of experiment will be found satisfactory. To the margin of a blackened disc of card-board, was cemented a silvered glass bead. This was set into rapid rotation in a dark room, and in close proximity to the flame in the glass tube. While the flame was silent, there was presented to the eye fixed upon the revolving bead, a complete luminous circle, which, when the flame began its song, was broken up into detached beads of light. By increasing the velocity of the disc, these brilliant points, or lumps, were reduced in number, and stretched into separated luminous arcs. The tube used was three feet long, and it was found possible to secure such a speed as to have only five luminous arcs. If the revolving mechanism be furnished with a counter or register, like the syren, we have here a simple and ready method of determining the number of vibrations per second of a sounding flame. For this purpose the bead should be light, and the disc small. For lecture-room illustration, the silvered ball should be large, so as to give a larger image of the flame, and a more voluminous bright circle.

To illustrate the use of the method suggested above, let me cite the following measurements. Employing a glass tube, $3\frac{1}{8}$ feet long, with an average diameter of nearly $1\frac{1}{16}$ inches, and keeping the bead whirling so as to present five stationary luminous arcs, the first and second observations gave, each, 1576·8 rotations of the disc in 43 seconds. The third and last gave 2014·8 rotations in 56 seconds. Giving to each observation the same weight, we have 182·2 vibrations of the sonorous flame per second.

The syren, applied to the same problem, gave 177·7 vibrations per second, but it must be added, that I found it impracticable to keep my syren exactly in unison with the flame, at so low a note. Beats were heard during almost the entire period (90 seconds) of the experiment.

The note in question, compared with those of a set of excellent tuning forks made by Ritchie of Boston, was nearly F.

Again, the luminous arcs were, as nearly as I could judge, about 48° each in extent. This being so, the light of the sounding flame endured *conspicuously* at each pulsation, $0^{s}\cdot00366$ or $\frac{1}{273}$ of a second.

It was noticed too that each arc varied in brightness, the point of maximum illumination being, not at the center of the arc, but beyond it; so that it would appear that in each luminous interval, the flame lost its light more rapidly than it acquired it.

I have spoken of the luminous arcs as though they were absolutely detached from each other. So they appear to a careless observer. A close scrutiny, however, revealed an extremely faint and fading thread of bluish light uniting them. Hence, in this case at least, we cannot accept Dr. Tyndall's conjecture that there is an *absolute* extinction periodically, of the singing flame.

3. *Supplement to Prof. Smith's paper;* by the author.—I have applied the revolving silvered ball to the solution of the following problems. (1.) *To adjust two sounding flames to exact unison*, or to test the perfection of accord between two apparently unisonant flames.

The revolving ball presented to the two flames, gives two intersecting circles of images, which, in case of exact unison, are equal in number, and present identically the same retrogradations, stations and advances during the variable motion of the ball.

(2.) *To determine the exact, or the approximate, value of the musical interval between two sounding flames.* Adjusting the velocity of the ball, so that each flame gives a circle of *stationary* images (luminous arcs), the relative number of these images will express the interval required. Thus for one pair of flames, I found the interval to be 2 : 1; for another pair 4 : 3.

If, when one set of images is stationary, the other set has a slow motion, the relative number of the images will give an approximate value of the interval, the direction of the motion with respect to that of the ball determining whether the value is too large or too small.

For these applications it is obviously unnecessary for the rotating mechanism to be furnished with a register. Indeed a kaleidophone might be used for the same purposes, though with some inconvenience. The silvered balls I have employed, vary from ½ inch to 2 inches in diameter.

It is scarcely necessary to apprize the readers of this Journal, that the method herein set forth is a simple modification of an experiment devised and described by Prof. W. B. Rogers.*

In the progress of these experiments, it was often noticed that the luminous arcs, or stretched images of the sonorous flame, were placed in echelon. The reason is manifest, when the silvered ball is revolved slowly and close to the flame. The separate images are then found to be inclined in the direction of revolution, their inclination augmenting with the velocity of the convex mirror, and the slope of the after edge of the image being steeper than that of the front edge. The same tilting of the images occurs, as is well known, in resolving the flame either by Wheatstone's or Tyndall's processes, when the mirror, plane or concave, is rapidly turned. I am not aware that the significance of this fact has attracted attention. Does it not indicate that the flame both recovers and *loses* its light progressively from base to summit, the loss being more rapid than the recovery; and that at no single instant of its history, is the sounding flame such in *size* and *form*, as it appears to be when steadily viewed? Moreover, if the flame, in any case, be rekindled from above, as it must be, if it is ever absolutely extinguished while sounding, it would seem that its image on its first edge at least should be tilted *in a direction opposite to the motion of the mirror.*

I shall conclude these notices by stating a fact bearing upon the theory of these flames. I have found no difficulty in causing the flame to sing when inserted quietly into a horizontal tube, *carefully leveled.* Tubes of various lengths and diameters were used. In narrow horizontal tubes, the vibrations are soon arrested by the accumulating products of combustion. In a tube 1¾ inches in diam. and 3 feet long, the flame sang for an indefinite time. While it was sounding, no drifting of smoke previously introduced into the tube, or of a column of smoke rising past its distant end, could be detected. It is easy to pass from the ordinary *erect* position of the tube and gas jet, through all grades of inclination, to *the inverted position of both, without cessation of the sound,* and without disturbing the *axial* position of the flame.

If by maladroit handling, the flame is silenced at the critical attitude, it will be observed that the latter is below the horizontal position.

4. *On a convenient form of Aspirator;* by Prof. ALBERT R. LEEDS, of Haverford College, Pa.—A pail containing water is placed at the edge of the table, and to the stop-cock which is attached to the side of the pail near the bottom, a tube of two or three feet in length is connected to carry off the water to a bucket placed on the floor below. When the bucket is filled, the stop-cock is turned off for a moment, and the water poured back into the pail. To the top of the stop-cock tube, which should be made

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* This Journal, vol. xxvi, p. 10.

straight and somewhat longer than usual, and in front of the stop-cock itself, a short vertical tube is attached and connected by means of india rubber tubing with the wash-bottle or other vessel through which gas is to be drawn. On partially opening the stop-cock, the deficiency of water is made up by a large quantity of air or gas, which is drawn in through the vertical tube above mentioned.

Writing on a Screen.—Every lecturer has felt how unsatisfactory it is to write or draw or in any manner attempt to illustrate his ideas in a large room. This difficulty may be overcome in the following manner: A plate of glass is placed in the limelight or magnesium lantern, and an inverting prism put in the forward part of the draw-tube of the objective. If now, while looking and lecturing to the audience, writing is done with an ordinary pen and india-ink upon the glass plate and proceeding from left to right upon the plate, it will advance correspondingly upon the screen and will be read in greatly enlarged characters by those present. The square prism inverts with respect to bottom, and the writing being actually reversed by the writer in reference to the other direction in which the lantern is pointing, the crossing of the rays produced by the lens becomes in this case an advantage and corrects the letters upon the screen. A collodion film blackened by exposure to the sun's rays, may be substituted for a naked glass plate to great advantage. On such a film, chemical and mathematical formulæ, drawing of apparatus, machinery, crystals, anatomical delineations, etc., may be cut with the utmost delicacy, and appear as intensely bright white lines on a black ground, and with something of the appearance of an immense copper-plate engraving.

5. *Height of Mt. Washington.*—The height of Mt. Washington, attributed on p. 378 of last volume by this Journal to Prof. Bond, was obtained by Prof. Guyot.

OBITUARY.

Dr. Samuel Luther Dana died at Lowell, Mass., March 11th, 1868. His death resulted from a fracture of the thigh bone caused by falling on the ice some weeks before.

Dr. Dana was born at Amherst, N. H. in 1795. He fitted for college at Phillips Academy, Exeter, and entered Harvard University at the age of fourteen. Immediately after graduation he went into the army, and served as lieutenant of artillery till the close of the war of 1812. Completing his medical course of studies in 1818, he practiced as a physician for a few years. But having a special fondness for chemistry he relinquished his medical practice to engage in the manufacture of chemicals and continued to superintend the works of the Newton Chemical Company for many years. In 1833 he accepted a situation as chemist of Merrimac Print Works in Lowell, a position which he held up to the time of his death. He devoted himself with great skill, zeal, and industry to matters connected with calico printing, and contributed much to the success of the Company, by whom he was employed. Being of a progressive disposition he conceived some peculiar ideas respecting the bleaching of cotton, which were communicated to the Société Industrielle de Mulhouse, and published in their Bulletin in 1836. His plan, which is now very generally used, is commonly known as the "American method" of bleaching.

By his investigations into the action of cow-dung in clearing mordanted calico of the thickening, he was naturally led to inquire into the nature of manures in general, of mold and the substances then little known but afterward more fully examined by Mulder and others and distinguished as gein, harmin, and ulmin. The collateral knowledge thus acquired was freely communicated to others and awakened so great an interest that he was at length induced to issue a treatise on the chemistry of soils and manures, under the quaint title of "A Muck Manual for Farmers." He also wrote an essay on Manures, for which he received a prize from the Massachusetts Society for Promoting Agriculture. In point of time, originality, and ability, Dr. Dana stood first among scientific writers on agriculture in this country.

But the agricultural treatises by which he became so well and favorably known, were but the secondary results of his research into the nature of cow-dung. The original object was worked out with full success. He found that the property of fixing mordants is due, in a great measure, to the presence of phosphates, and that the bulky animal excrement might be effectually replaced by cheaper and more convenient phosphate of soda prepared from bones. But Dr. Dana being the employee of a manufacturing company, was not allowed to secure a patent or to make the discovery known to the world. It was, however, of too much value and importance to remain long a secret; and when another person went to England with a full knowledge of the experiments at the Merrimac Print Works, and sought to derive a pecuniary benefit from the discovery, it was found that Mercer had been making similar trials with arseniate of soda. In fact the English and the American chemist independently originated the use of the dung substitutes, but to Mercer belongs priority of time by a few months.

In 1840 Dr. Dana made a report to the City Government of Lowell, on the various well-waters of the city, with special reference to their action on lead pipes. And for the sake of making more generally known the character of slow poisoning by lead, a matter then little understood by physicians themselves, he superintended the translation and publication of Tanquerel on Lead Diseases, the work of translation being done chiefly by his daughters.

In 1851 the manufacture of rosin oil was brought to his notice and he contributed much to the improvement of that then important branch of industry.

In later years his time was taken up by the duties of his position and the cultivation of a farm which he had purchased for the purpose of testing his peculiar views. Dr. Dana was of a retiring nature and was seldom away from the scene of his daily labors. Those who sought him out would not fail to be most favorably impressed by his geniality, his readiness to communicate knowledge, and his evident integrity of character.

V. MISCELLANEOUS BIBLIOGRAPHY.

1. *Elementary Introduction to Practical Mechanics.* Illustrated by numerous examples: being the third edition of "Elementary Examples in Practical Mechanics," by JOHN F. TWISDEN, M.A., Professor of Mathematics in Staff College. London, Longmans, Green, & Co. 1868. pp. 320.—Nothing so thoroughly fixes mathematical principles in the mind, as the working of examples. This conviction seems to have been acted upon by the author of the work before us. Indeed, his book, in its first editions, was professedly a collection of examples intended to supplement other treatises. But, in this third edition, it has been enlarged by the addition of such statements and demonstrations of principles, as make it now an independent work. It differs from other elementary treatises, both in the more practical turn given to the whole subject, and, especially, in the very large number of examples—over 800 in all. The examples appear to have been judiciously selected and to be particularly adapted to the wants of students in Engineering, whether Civil, Mechanical or Mining. The work seems to us an excellent one to follow any first book of Theoretical mechanics, such as *Peck's Elements.* We very much wish that a reprint of it, or some American work on a like plan, were published as a text book, for use especially in our schools of science.

2. *Berghaus's Chart of the World* (4th edition), published by Justus Perthes, Gotha. B. Westermann & Co., New York. Price $10.—This beautiful chart exhibits in the neatest and most perspicuous manner a greater amount of physical and commercial information than can be found in any other atlas. The exquisite finish of the maps issued by Justus Perthes is too well known to require commendation; nothing in this line of art elsewhere prepared is equal to them. This World-chart is drawn on the Mercator Projection, the longitude starting from Greenwich. It shows the tracks of those lines of sailing packets, steamboats and telegraphs, which now form the connecting links between the continents and islands of the globe; the streams and currents of the oceans and of the drifting ice; the shallow-water and deep-sea-soundings; the distances between the principal ports and the mean-time occupied in the trips of 57 various lines of steamers and sailing packets; and also the continental railroads and telegraphs, particularly those that communicate direct with steamer-lines. Additional maps, on a larger scale, of the Isthmus of Suez, of Panama, of Nicaragua and of Tehuantepec, a map of the plani-globes on Polar Projection, a wind-chart and a map showing the lines of equal magnetic declinations fill the corners and other vacant spots of the chart.

A separate edition is issued in the language of each of the great commercial nations, and it has been adopted by the Bureau of Charts for the U. S. Navy.

3. *Organic Philosophy.* Vol. II. *Outlines of Ontology, Eternal Forces, Laws and Principles;* by Hugh Doherty, M.D. 455 pp. London, 1867. (Trübner & Co.)—The publication of the first volume of this work was noticed in vol. xxxviii, 1864. The author divides his work into two parts; 1st, investigation of principles, and 2nd, discussion of principles. Under the first part occur the following heads of sections: Unity of science; Methodological sciences, Astronomical sciences; Ontological sciences; Transcendental philosophy; Perfective philosophy; Evolutive philosophy (in which and elsewhere he opposes strongly the hypothesis of Darwin); Constitutive philosophy; and part second includes the three sections: Evolutive facts and theories, Philosophies, Theosophies and Theologies. The work is condensed in the statements of its views, and in parts somewhat abstruse, but is one that may be read with much profit.

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